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ABSTRACT

Of 102 educable mentally handicapped children in special classes, 54 were identified by the Purdue Perceptual Motor Survey (PMS) as deficient in perceptual motor abilities. These 54 children were assigned to one of the following groups: training, which participated in an individualized, structured perceptual motor program twice a week for 4 1/2 months; Hawthorne, which met with the trainer but played table games; and control. Achievement and intelligence tests were given. The hypothesized improvement in perceptual motor abilities did not manifest itself, although children under 10 years of age in the training group scored significantly higher on the PMS than did controls of like age. Nor did hypothesized improvement in intellectual performance, or achievement result. However, all three groups improved significantly on PMS and achievement test scores; and training and Hawthorne groups showed significantly improved IQ scores. Thus, evidence suggested a correlation between perceptual motor ability and the variables of intelligence and achievement. (Author/JD)

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FINAL REPORT

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EFFECTS OF A STRUCTURED PROGRAM OF PERCEPTUAL-MOTOR TRAINING ON THE DEVELOPMENT AND SCHOOL ACHIEVEMENT OF EDUCABLE MENTALLY RETARDED CHILDREN

Kirk L. Fisher

The Pennsylvania State University

University Park, Pennsylvania

September, 1969

U. S. DEPARTMENT OF

HEALTH, EDUCATION, AND WELFARE

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Effects of a Structured Program of Perceptual-Motor Training on the Development and School Achievement of Educable Mentally Retarded Children

by

Kirk L. Fisher

An Abstract of a
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September, 1969

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Effects of a Structured Program of Perceptual-Motor Training on the Development and School Achievement of Educable Mentally Retarded Children

This study was designed to experimentally test the effectiveness of a structured program of perceptual-motor training, following Kephart's principles, with educable mentally retarded children. The literature clearly indicates that mentally retarded children are inferior to normal children in motor performance. Experimental studies, however, have suggested that motor proficiency in the retardate can be significantly improved through training. There have been some indications in the literature that motor proficiency is related to intellectual functioning, particularly among retarded children and, furthermore, some investigators have reported increases in intelligence test scores as a result of motor training. If we postulate some interference in perceptual-motor development as a possible etiological factor of poor motor performance in the mentally retarded, and if this poor motor performance can be remediated, we would expect a concomitant improvement in perceptual processes as well.

Method

Of 102 educable mentally retarded children enrolled in public school special classes in an urban area who were tested with the PMS, 54 children were determined to be deficient in perceptual-motor abilities. Each of these 54 children was randomly assigned to one of three groups. Children in Group T (Training) participated in an individualized, structured program of perceptual-motor training twice each week for four and one-half months. Children assigned to Group H (Hawthorne) also met with the trainer but played table games instead of doing perceptual-motor training. Group C (Control) children maintained their regular classroom schedules.

All of the children in the three groups responded to the PMS, WISC, WRAT, and SAT before training began. Following training, the PMS and WISC were administered to all of the children. Two months later, the two achievement tests were administered to the same group.

Results

Hypothesis I, which predicted improvement of perceptual-motor abilities as a result of training, was not supported. Analysis of covariance of PMS scores, using age and PMS prescore as control variables, revealed no significant differences among the three groups. A separate analysis computed for those children under 10 years of age, however, revealed a significant difference in favor of Group T over Group C on PMS total score. The difference between Group T and Group H was very close to statistical significance at the .05 probability level.

Hypothesis II which predicted improvement in intellectual performance was not supported. The $\underline{F}$ ratio from the analysis of covariance of WISC Full Scale IQ's was not statistically significant at the .05 level. For Hypothesis III which predicted improved achievement, no support was found. The covariance applied to both WRAT and SAT scores, using age and prescore as control variables, yielded $\underline{F}$ ratios which were not statistically significant.

All three groups of children demonstrated significant improvement from pretest to posttest on PMS total scores and on both achievement tests. In addition, both Group T and Group H showed statistically significant improvement in WISC Full Scale IQ, suggesting the importance of the Hawthorne effect on intelligence test performance.

Conclusions

Although there is some evidence that a short term program of training in perceptual-motor abilities may be effective in improving the perceptual-motor performance of educable mentally retarded children younger than 10 years, there is no evidence that such short term training affects the intellectual functioning or the school achievement of such children. Evidence has been presented, however, that a correlation does exist between perceptual-motor ability and the variables of intelligence and achievement. Several important variables for future research are suggested by the results of this and similar studies.

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Kirk L. Fisher

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September, 1969

Joseph L. French, Sponsor

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CHAPTER I

INTRODUCTION

The investigation described herein was designed to test the effectiveness of a structured program of perceptual-motor training activities with educable mentally retarded children. Most of the recent work in using special training techniques has been primarily concerned with children who have some type of learning disability. Several special schools for children with learning disabilities have adopted programs of perceptual-motor training in an effort to improve the learning ability of their students. Professor Newell Kephart and his colleagues at the Achievement Center for Children at Purdue University have long argued the importance of such training for improving the performance of slow learners. Despite the apparent usefullness of programs of this type, there have been embarrassingly few experimental studies which have examined the outcome variables of such training programs. Furthermore, there has been very little application of such programming with mentally retarded children. The present study is an attempt to experimentally evaluate the effects of a program of perceptual-motor activities on elementary school mentally retarded children.

The relationship between motor proficiency and intellectual functioning has not been definitely established by research. Several writers, however, have emphasized the importance of this relationship. (Barsch, 1963; Delacato, 1963; Kephart, 1960) Each of these authors has suggested that many higher forms of behavior develop out of motor learning.

It is also pointed out that the performance of motor skills is dependent upon feedback from the sensory systems of the organism, so that perceptual processes are an integral part of any motor activity. Kephart suggested that the term perceptual-motor should be used to indicate the interrelatedness of the perceptual and motor processes.

Perceptual-Motor Hypothesis

Professor Kephart in his writings (e.g., Kephart 1960, 1966; Roach and Kephart, 1966), has set forth a set of principles concerning the relationship between these two processes. For the purposes of the present paper this set of principles will be referred to as the Perceptual-Motor Hypothesis. The essence of this hypothesis is a sequence of learning stages through which the child progresses. Later complex learnings are built upon initial motor learnings in a hierarchical fashion. Perceptual-motor orientation to the environment is the foundation for symbolic and conceptual activities.

The child must first develop consistent and efficient motor patterns or generalized movements. Such movement patterns permit the child to use a movement or a series of movements for a purpose. "Attention can largely be diverted from the movement to the purpose" (Roach and Kephart, 1966, p. 6-7). This allows the child to explore his environment and systematize his relationships to it. In order for the child to successfully interact with his environment he must be oriented to gravity as well as space and time.

Kephart (1966, p. 172) maintains that "there are four motor generalizations that are of particular importance to education because of their relationship to a space-time structure." He identifies these as:

1. Balance and maintenance of posture

   Involving those abilities by which the child maintains his relationship to gravity.

2. Locomotion

   Involving observation of the relationships between objects in space by moving from one to another.

3. Contact

   Involving those activities by which the child manipulates objects. Reach, grasp and release are involved here.

4. Receipt and Propulsion. Receipt

   Involving those activities by which the child makes contact with a moving object, and

   Propulsion

   Involving those activities by which the child imparts movement to an object.

These motor patterns provide the basis for meaningful orientation because the child can begin to compare sensory data with the already systematized motor information. Kephart has referred to this comparison as the perceptual-motor match. On the basis of this perceptual-motor match, perceptual data become systematic and come to mean the same thing as the motor data. "Among the perceptual fields, it appears that the tactual and kinesthetic are the first systems to be integrated through such matching. Later, visual and auditory information are integrated" (Roach and Kephart, 1966, p. 8-9). When the perceptual information has been integrated and systematized so that consistent information concerning outside objects becomes available to the child, generalizations such as form perception, directionality and, later, concept formation become possible. Some of the more important motor generalizations which are considered essential for later learning are laterality, directionality, body image, and concept formation. (See Definition of Terms section of this chapter.)

It is important to note that each of the aspects of motor performance mentioned above involve learning. These learned motor behaviors are developmental in that each one depends upon the prior development of the preceding one. Of course those mentioned are only the most important ones. Other similar learned motor patterns are also involved in the developmental sequence.

The postulate of the Perceptual-Motor Hypothesis which was of major concern in the present investigation is that many learning difficulties are the result of a breakdown in this perceptual-motor developmental sequence. The effect of this breakdown is to interfere with the establishment of a stable perceptual-motor world, with the result that the child is presented with symbolic and conceptual materials in the classroom, even though he has not yet established an adequate orientation to space and time. Kephart (1960) believes that with many slow learning children it is often necessary to return to basic motor patterns to permit the child to recapitulate the process of development by which finer and more complex patterns are achieved. Kephart and his colleagues at Purdue University feel that a planned sequence of exercises designed to develop motor generalizations and orientation in space and time can be effective in remediating learning problems for many children who have experienced difficulty with early motor learning.

One of the primary difficulties with the Perceptual-Motor Hypothesis is the lack of a rigorous rationale relating the prescribed exercises to particular aspects of perceptual development. The relationship is described only in general behavioral terms. The neuro-physiological processes involved are not explicitly detailed. Despite this weakness, it is still possible to determine the efficacy of employing the treatment procedures described by Kephart to improve perceptual-motor performance.

Kephart has written primarily about slow learners and children with learning disabilities. It is not difficult, however, to extend the principles of his hypothesis to the mentally retarded child who, because of faculty learning processes, has failed to adequately develop motor generalizations.

Rationale and Importance of the Present Study

It is generally accepted in the literature that mentally retarded children are inferior to normal children in motor performance. (Francis and Rarick, 1963; Howe, 1959; Malpass, 1960; Sloan, 1951) Although these descriptive studies have presented a rather bleak picture of the motor capabilities of children who are mentally retarded, experimental studies have shown that motor proficiency can be improved in the retardate. (Corder, 1966; Oliver, 1958; Solomon and Pangle, 1967) Furthermore, Solomon and Pangle (1967, p. 177) report that, as a result of their training program, the level of physical fitness in educable mentally retarded boys "can be so significantly improved as to allow a favorable comparison with the nonretarded peer group."

These investigators employed a 45 minute per day program of physical fitness with 24 experimental group boys (ages 13-5 to 17-3). The program was continued for eight weeks for this group of educable mentally retarded boys. Significant gains were found on the American Association for Health, Physical Education and Recreation Youth Fitness Test (1961). After training, the experimental group compared favorably with the published norms for children of the same chronological age.

Other studies have shown that structured physical education programs with the mentally retarded may affect cognitive functioning as well as physical proficiency. Oliver (1958) provided ten weeks of systematic and progressive physical conditioning for a group of 19 educable mentally retarded boys (IQ's 54-86) in a residential school in the United Kingdom. A control group of 20 boys from another school matched as nearly as possible in terms of age, intelligence, size and physical condition continued in their regular school program. The age range for both groups was 12 to 15. The results of the study showed a significant increase in Binet IQ as well as improvement in motor proficiency made by the experimental group.

Corder (1966) carried out a similar experiment but controlled for the Hawthorne effect by having one of his groups of eight boys act as "officials" for the experimental group. The "officials" recorded the activities of the training group and rated their performance. A third group of retarded boys maintained normal classroom schedules. The age range for all three groups was 12 years to 16 years and 7 months. Statistically significant differences in IQ gain scores were found in favor of the training group over the control group on WISC Full Scale and Verbal Scale IQs.

The available evidence supports the idea that perceptual training does lead to improved perceptual ability. (Gibson and Gibson, 1955; Halgren, 1961; Hilgard, 1961) This has been demonstrated to be true for mentally retarded children as well as normals. (Allen, Dickman, and Haupt, 1966) There is also evidence that practice in motor activities improves motor performance. (Corder, 1966; Oliver, 1958; Solomon and Pangle, 1967) From the interrelatedness of perceptual and motor processes, it seems to follow that perceptual-motor training should enhance perceptual-motor ability. This should hold true for mentally retarded children as well as normals since the previously cited studies have shown that physical training with mental retardates can increase their physical proficiency to a level comparable to that of a peer group. (Solomon and Pangle, 1967) If we postulate some interference with a particular stage of perceptual-motor development as a possible etiological factor of poor motor performance in the mentally retarded, and if this poor motor performance can be remediated, we would suspect a concomitant improvement in perceptual processes as well. This explanation may account for the increase in intellectual functioning as a result of the physical education programs of Oliver (1958) and Corder (1966). The present study was an attempt to assess the effects of a perceptual-motor training program with educable mentally retarded children. Specifically, the following question was posed: *What are the effects of a structured program of physical activities, consistent with Kephart's conceptualization of the Perceptual-Motor Hypothesis, on the perceptual-motor development, intellectual development, and school achievement of public school educable mentally retarded children who have shown evidence of poor perceptual-motor abilities*?

If it could be shown that a carefully sequenced program of perceptual-motor activities could be of real benefit for a group of retarded children, it might persuade special educators to implement a developmental sequence of perceptual-motor training into the regular curriculum. Many curricula for educable mentally retarded children have neglected the area of perceptual-motor development.

If the training could also be shown to yield significant gains in level of intellectual functioning, this information would be useful to the theorist who speculates on the nature of intellectual processes. It may be that a developmental arrest of perceptual-motor functioning may seriously hamper development of higher level processes and that remediation of such an arrest may significantly improve general intellectual functioning.

If it could be shown that the training used in this study was not effective, educators may have a rationale for emphasizing other types of learning activities which have been shown to be of significant value.

Previous Research

At least three very recent studies have had direct bearing on the problem posed in the present investigation. Alley and Carr (1968) conducted a study using two groups of 28 educable mentally retarded children. The children of both groups ranged in age from 7 years and 5 months to 9 years and 10 months. The IQ range was 49 to 77. The experimental group was subjected to a systematic perceptual-motor training program based on activities as presented by Kephart (1960).

A criterion of three successful trials on each training task was set. Supplemental activities designed by the investigators were used with each child who had completed the Kephart program. The overall amount of training was the same for each child in the experimental group.

The control group received no training. Ten criterion measures were administered to all children both before and after the training. Included were tests of perceptual motor ability, visual perception, and concept formation.

> Both the experimental and control groups' mean scores on all criterion measures reflected improvement from pretest to posttest administrations. However, when the analysis of covariance was applied, no significant differences were evident between the adjusted posttest mean scores of the two groups. (Alley and Carr, 1968, p. 451)

The authors concluded that educable children do not benefit more from a systematic perceptual-motor program than from general special education classroom activities.

Heriot (1966) provided a motor training program based on Kephart's work for 12 preschool mentally retarded children (IQ's: 31-79) for two hours daily over a complete school year. A battery of psychometric tests was administered both at the beginning and end of the year. Although no control group was involved and the number of subjects is small, the author reported that statistically significant gains were found between pretest and posttest scores on tests of intellectual, perceptual-motor, and language development. The author concluded that "In the 5 and 6 year old retardate, using the motor approach described by Kephart, there is encouraging evidence that these gains can be achieved in less than one school year . . . ." (Heriot, 1966, p. 40)

Haring and Stables (1966) carried out a study to determine the effects of gross motor training on visual perception and eye-hand motor coordination. The study was designed to test Kephart's closed cycle theory which suggests that perceptual and motor activities work together in one process. The investigators devised a test to measure eight aspects of perceptual-motor functioning. There were 11 educable mentally retarded children (ages 7 to 15) in the experimental group and 13 in the control group. Each child was first evaluated with the Purdue Perceptual-Motor Survey and then trained according to his greatest deficits as measured by that survey. The training was done in a group setting with attempts to meet individual needs. The training was conducted for one-half hour each school day for seven months. The results led the authors to conclude that gross motor training significantly affected the scores of the experimental group on the Visual Perception, Eye-Hand Motor Coordination Test in a positive direction. The differences between the experimental and control groups was still statistically significant on a follow-up test after four months.

The research done to date has been inconclusive and often contradictory in that Haring and Stables found training to be effective while Alley and Carr did not. Heriot, although reporting success, used no control group. None of the three studies evaluated the Hawthorne effect. The problem posed earlier in this chapter remains essentially unresolved. Lack of control for Hawthorne effects limits the generalizability of the reported studies. Furthermore, training has been done with randomly selected groups without regard to the present capabilities of the children. The investigation reported in this paper attempted to correct some of these design difficulties.

Hypotheses

The present study employed a training procedure similar to that used by Alley and Carr, except for the spacing of the instructional sessions. It was similar to the Corder investigation in that the Hawthorne effect was accounted for. In accordance with the Painter study (1966), the present project dealt only with those children who were deficient in the kinds of skills remediated by the exercises. The hypotheses posed in the present experiment follow.

Hypothesis I: *A program of structured training in perceptual-motor abilities will result in an increase in perceptual-motor ability with educable mentally retarded children who were deficient in those abilities*. This first hypothesis predicted that the training program will improve those abilities which are included in the training. Arguments against "teaching the test" can be leveled here but the essential purpose was to evaluate whether or not training really did what it was intended to do (i.e., improve perceptual-motor abilities). This hypothesis also would lend support to the validity of the instrument used.

Hypothesis II: *A program of structured training in perceptual-motor abilities will result in an increase in the level of intellectual functioning of educable mentally retarded children who were deficient in perceptual-motor abilities*. Analysis would also be made of the separate Verbal and Performance IQ's in order to determine the differential effects of the training procedure. Corder (1966) found that a group of educable mentally retarded boys given physical education training made significant mean Verbal IQ gains over a control group, but the same result was not found with Performance IQ. However, the emphasis on perceptual abilities in the present study as contrasted with the heavy emphasis on motor skills and verbal participation in a group setting as in Corder's study led this investigator to predict a reversal of Corder's finding. Hypothesis II (A): *The perceptual-motor training procedure will result in an improvement in Performance IQ but not in Verbal IQ*.

Hypothesis III: *A program of structured training in perceptual-motor abilities will result in an increase in the overall achievement level, following a one year period in the classroom, of educable mentally retarded children who are deficient in perceptual-motor abilities*. The training program would be of questionable value if achievement gains did not follow. It is doubtful whether the gain in achievement which might result from the program would be manifest immediately after the training is concluded, so no prediction was made in that direction. Furthermore, educators are interested in long lasting effects rather than short-lived ones. For these reasons, a three month period of continued learning in the classroom, following the training program, was allowed before achievement testing was done.

The prediction of achievement gain was based partially on tangential support from correlational studies in the literature. Lowder (1956) tested every pupil (N=1510) in the first three grades of a public school district with a test of outline form perception (copying seven geometric forms). The score assigned to total copying performance correlated about .50 with teachers' evaluations of school achievement. Lowder used, as his test, the same seven geometric forms which are included as one of the subtests of the Purdue Perceptual-Motor Survey. The predicted relationship between perception and school achievement in the lower grades was supported.

Roach and Kephart (1966), in the standardization of the Purdue Perceptual-Motor Survey, found that, for 296 subjects in the first four grades of an Indiana school, total score on the survey was correlated .65 with teachers' ratings of overall academic performance.

More recently, perceptual-motor training programs have been demonstrated to be effective in improving academic achievement. McLanahan (1967), Swanson (1968), and Ismail and Gruber (1967) were able to show achievement gains as a result of their training programs.

Definition of Terms

A few of the terms used in this paper require some elaboration for clarification of meaning, especially some of those terms relating to Kephart's Perceptual-Motor Hypothesis.

Perceptual-Motor Match

The development of perceptual organization, according to Kephart, is dependent upon the prior formation of a consistent body of information in the motor system. Initially, meaningless perceptual data are matched to the already existing structure of the motor system and, thereby, develops meaning for the child. Through experimentation, incoming perceptual information comes to mean the same thing as the motor information. Since the motor information is assimilated by the child first, it is logical that the perceptual data be matched to the motor data, not the opposite. It should be emphasized that the motor system need not be complete in its development before this matching process begins but an initial body of information would have begun to build up.

Posture

This most basic movement pattern refers to the maintenance of the position of the body with reference to its center of gravity. Balance is one aspect of posture. The zero point for all directions and orientations in space is the gravitational axis of the body. The most important aspect of posture in the developmental sequence is flexibility. Postural flexibility is essential before further motor development can be effectively accomplished.

Laterality

A consistent awareness of the right and left sides of the body indicates that a child has developed adequate laterality. There are no objective directions in space. Right, left, up, and down are projections onto external space on the basis of activities which take place in the organism as a result of movement. The first of these directions to appear in most children is usually laterality or the awareness of the right and left sides of the body. The bilaterally symmetrical human body and nervous system makes this awareness relatively easy but it must be learned. Some children avoid the laterality learning problem by making only bilaterally symmetrical movements, or, at the opposite extreme, using only one side of the body while dragging the other side along.

Directionality

The projection of laterality onto external space results in a concept of directionality. In order to make contact with an object, a child learns to make a movement (e.g., to his right). He then reverses this deduction and learns the concept of an object to the right of himself. Eye control is important here because, rather than actually making the movements toward an object, the more experienced child usually will move his eyes instead. Kinesthetic feedback from the eye muscles is, therefore, essential. In general, the eye provides the intermediate step in transferring laterality to directionality.

Body Image

Closely related to the concepts of laterality and directionality is the notion of body image. It has already been suggested, in discussing posture, that a reference point around which to organize our perceptions of space is essential. As a result of sensory experience the child develops a mental image of the way his body appears to him. The body image then becomes the point of origin for all of the spatial relationships among objects outside of his body. The body image is necessary for efficient movement. A child must be aware of the spatial location of a body part, for example, in order to know which direction to move it to reach some other point.

Concept Formation

The learning of concepts could be defined as the manipulation of relationships between percepts with the resulting emergence of unique elements (Strauss and Kephart, 1955). From the Perceptual-Motor Hypothesis it can be seen that solid concepts depend on well-established percepts which in turn depend on solid basic motor patterns. If the initial development of motor patterns is inadequate, later conceptual development will be limited.

Summary

In this chapter an attempt has been made to define the research problem which is investigated in this project. The problem was stated in general terms before Kephart's position on the issue was summarized. The rationale and importance of the present study were discussed and the specific problem for this study were presented. A brief review of previous research related to this problem was presented, the specific hypotheses investigated in the present study were listed, and finally, some confusing terms were defined. The next chapter will include a more extensive review of research related to the present problem.

CHAPTER II

REVIEW OF RELATED RESEARCH

There have been a number of research reports in the literature concerning the motor and perceptual-motor abilities of the mentally retarded and the possibilities for improvement in these abilities. The present research project is based upon the results of many of these studies. Such investigations logically fall into three categories and will therefore be categorized under three headings in this chapter. A review of studies concerning the relationship of motor proficiency and intelligence will be presented first. The effects of motor training with the mentally retarded has important implications for the present study, so that studies relating to that topic will be included under a second hearing. Previous research on the effects of perceptual-motor training with the mentally retarded are reviewed in a third section.

Motor Proficiency and Intelligence

Comparison of Mentally Retarded and Normal Children

A number of studies have been conducted which compared the motor abilities of mentally retarded children with those of normal children. Sloan (1951) selected 20 mentally retarded children from a state institution and 20 mentally normal children from public schools in the same geographic area. Both groups were equally divided according to sex. All of the children were within 18 months of being 10 years of age. The IQ range for the mentally retarded group was 45 to 70 and for the normal group the range was 90 to 110. When these two groups of children were compared using Sloan's 1948 adaptation of the Lincoln-Oseretsky scale of motor proficiency, it was found that the normal group was significantly superior on all six subtests of the scale.

Malpass (1960) compared two groups of mentally defective children with a third group of normal children. From an institution for the mentally retarded, Malpass selected 52 children with IQ's between 50 and 80. Another group within the same IQ range was selected from public school classes for mentally retarded children. A third group of 71 normal children (mean IQ approximately 110) was also selected. The average age for the children in each of the three groups was between 11 and 12 years. The age range was 8 to 14 for each group. Sloan's (1955) revision of the Lincoln-Oseretsky Motor Development Scale was administered to each of the children. The results indicated that both mentally retarded groups were significantly inferior to the normal children in motor development. The scale did not differentiate between the two mentally defective groups.

Howe (1959) also compared mentally retarded and normal children on a variety of motor skill tasks. The groups were matched on chronological age, socio-economic background, and sex. The 43 children in each group were between 6 and 12 years of age. For this study, Howe selected 11 motor tasks with as little intellectual loading as possible. Each child was given three trials on most tasks and the best trial was recorded as the score. In summarizing the results, Howe concluded:

> For boys, the normal group was significantly superior to the retarded group on each of the 11 motor tasks. For girls, differences favored the normal group for all tasks, and all except grip strength and accuracy in throwing a ball at a target were significant at the five per cent level. (Howe, 1959, p. 354)

An additional finding in the Howe study was that only 2 of the 43 mentally retarded children were able to balance on one foot for 60 seconds. Of the 43 normal intelligence children, 28 were able to successfully complete this task.

Large numbers of mentally retarded school children in Wisconsin were compared by Francis and Rarick (1960) with published norms on six tests of motor ability. A total of 284 children between the ages of 7-6 and 14-6 were studied. The IQ's of these children were between 50 and 90. The 11 tests used were designed to measure strength, power, balance, and agility. It was found that the means of both mentally retarded boys and girls on most measures were two to four years behind the published age norms of normal children. It was also noted that the discrepancy between the normal and the mentally retarded groups tended to increase with each advancing year level. This tendency was most marked for the more complex skills.

Stein (1963, p. 232) summarized the research in the area of motor abilities of the mentally retarded and concluded: "When placed in physical education classes with normal children, most retardates are unable to compete safely and successfully or to participate adequately with their normal classmates." Stein also pointed out the apparent need for specialized motor training for the mentally retarded.

The differences between mentally retarded and normal children in motor performance were also demonstrated in a recent study by Keogh and

Keogh (1967). These investigators compared 39 educationally subnormal (ESN) boys with 84 mentally normal boys in England. The ESN boys were between 9 and 10 years of age, while boys 6 to 9 years old were included in the normal group. The children were rated on their ability to copy four simple line patterns by drawing and also to reproduce the patterns by walking on an unmarked floor. The results demonstrated that normal children can adequately reproduce the forms by age 7 or 8. The mentally retarded children were similar to 6 year olds on both copying tasks and were significantly poorer than all other age groups. No difference between walking and drawing ability was found for the normal group but the ESN boys were significantly poorer in walking than in drawing. The investigators reported that the ESN boys had extreme difficulty in organizing their gross movements to represent patterns. The findings were discussed in relation to Kephart's suggestion that pattern copying requires a kind of "temporal-spatial translation."

The overall concensus of the research comparing mentally retarded children with normal children on tests of motor ability is that the mentally retarded are inferior on those abilities. All of the studies cited report differences in favor of the samples of normal children. The research literature is not so clear when the nature of the relationship between motor ability and intelligence is examined.

Relationship of Motor Ability and Intelligence

The research cited in the previous section, of course, has some bearing on this question. If mentally retarded children are consistently inferior to normals in motor performance, the inference is that there is a relationship between IQ and motor performance. Although this relationship has been amply demonstrated through comparisions of such markedly different groups, the findings have been less conclusive when more homogenous samples were studied. Several studies have been conducted with mentally retarded children. Health (1942) tested 148 boys from Vineland Training School with his rail-walking test and concluded that there was a marked relationship between mental age and rail-walking performance for an endogenous group of mentally retarded boys but not for an exogenous group. The investigator reported that, for the endogenous group, rail-walking was more closely related to mental age than to life age.

Brace (1948) studied 50 institutionalized mentally retarded girls between 13 and 18 years of age, with IQ's ranging from 23 to 82. Several low positive correlations between motor ability and intelligence were found, the most significant (.53) being that between balance items and IQ.

Malpass (1960), as part of the investigation already described, administered the Wechsler Intelligence Scale for Children to each of the 107 mentally retarded children in his sample. He also gathered IQ's on the California Test of Mental Maturity for the children in his normal IQ group. After reporting correlation coefficients between the 1955 Lincoln-Oseretsky and the intelligence tests, Malpass concluded that motor proficiency was related to intelligence among the mentally retarded groups but not for the normal group.

Also using the Lincoln-Oseretsky, Rabin (1957) studied 60 institutionalized endogenous mentally retarded children between the ages of 10 and 14. Using a factorial design, Rabin was unable to demonstrate significant differences between two IQ levels. He attributed this lack of differences to inadequate control of certain variables and suggested that his results were probably in error on this point.

DiStephano, Ellis, and Sloan (1958) administered the Stanford-Binet Intelligence Scale as well as a battery of motor tests, including the Oseretsky, to 76 institutionalized mentally retarded persons from 9 to 32 years of age. They found no differences between Caucasion and Negro persons on the motor battery. The overall correlations between the Lincoln-Oseretsky and mental age on the Binet were .58 for females and .40 for males.

Studies examining the relationship between mental and motor abilities in normal children are inconclusive in their findings. As already reported, Malpass found that CTMM scores were not significantly related to performance on the Oseretsky. After a thorough review of the literature on the subject, Ismail and Gruber (1967, p. 33) concluded that "the relationships between intellectual performance and items measuring physical growth, strength, speed, and power were low and in some cases nonexistent." These authors noted, however, that little research had been done with items measuring the more innate motor aptitude domain including balance, coordination, and kinesthesis. The reader will recall that some of the highest correlations found in the research already reported were those relating intelligence with items measuring balance. (Brace, 1958; Howe, 1959)

Ismail and Gruber (1967) carefully studied the relationship of 36 motor aptitude items with intelligence (Otis) and achievement (Stanford Achievement Test). There were 211 fifth and sixth grade children between 10 and 13 years of age included in the study. The results indicated that speed, accuracy, power and strength did not correlate significantly with Otis Intelligence Test scores. Coordination items and some balance items were found to be significantly correlated with IQ. The investigators went on to assemble batteries of motor tests which could predict intellectual performance. In terms of prediction, coordination and balance items were the most important variables. Statistically significant relationships were also found between coordination and balance items and academic achievement. The authors concluded that the relationships may be related to the fact that balance and coordination items require intellectual analysis and formulation of a response which is then transmitted to the appropriate muscle groups. Many other motor items relate only to the proficiency of the muscle groups themselves. Most of the previous studies have included items of both types, perhaps explaining the general finding of low positive correlations.

Ismail and Gruber's work has helped to clarify the relationship between motor proficiency and intelligence. Their findings suggest that the differences between mentally retarded and normal children on motor items may be differences in the general functioning of the intellect. An important question then arises concerning the possibilities for improvement of motor abilities in mentally retarded children. The research on that point is presented in the following section.

Effects of Motor Training with the Mentally Retarded

Several of the investigations concerning the effects of motor training with mentally retarded children have already been mentioned. Howe (1959), in the study previously described, provided 10 days of practice for each of the 43 retarded and 43 normal children in his sample on three motor tasks. Results indicated that both groups showed similar progress in learning as a result of practice. The normal children achieved higher scores at the beginning and maintained the same degree of superiority throughout.

In a study conducted in the United Kingdom, Oliver (1958) matched two groups of educationally subnormal boys and gave a ten week course of systematic physical conditioning to one group of 19 boys in addition to regular classes in English and arithmetic. The other group of 20 boys in a different school continued their regular schooling. The boys were 14 and 15 years old and their IQ's ranged from 57 to 86. Both groups were tested before and after training on a battery of tests including tests of physical fitness and intelligence. Oliver found that the experimental group showed significantly greater gains in physical fitness than did the control group. He also demonstrated that the experimental group made greater gains on the Binet, Goodenough, and Porteus Maze tests. The author explained these increases in mental development on the basis of the effects of successful experience, improved social adjustment and confidence, and the effects of feeling important.

In order to control for such effects, Corder (1966) did a similar study but included a Hawthorne group. In this study, eight retarded boys

(IQ 50 to 80) were given an intensive program of physical education one hour each day for 20 days. Eight other retarded boys, designated as "officials," met each day with the training group. Each boy in this group was responsible for a daily rating of one boy assigned to him from the training group. In addition, the officials also kept daily records of the performance of the training group. A control group of eight boys maintained their regular classroom schedule. The boys in the training and officials groups were selected from one school while those in the control group were selected from two other schools.

The AAPHER Youth Fitness Test (1961) and the WISC were administered to all three groups before and after taining. Analysis of the results of the Youth Fitness Test demonstrated that the training group achieved significantly greater gains than did the other two groups, supporting the hypothesis that training improves physical performance. On the WISC, it was found that the training group made significantly greater gains than the control group but the differences between the training and officials groups were not significant suggesting that Oliver's reasoning about the Hawthorne effect was at least partially correct. Corder pointed out, however, that since the officials and controls did not differ significantly, either, something more than the Hawthorne effect must have been operating. In a related finding, Corder also demonstrated that the training and control groups differed on the WISC Verbal Scale but not on the Performance Scale.

Another investigation mentioned in Chapter I was that conducted by Solomon and Pangle (1967). These investigators evaluated an eight week training program in physical fitness with two groups of adolescent boys. The training group was composed of 24 mentally retarded boys from lower socio-economic backgrounds. There were 18 boys of similar intelligence and background in the control group. As in Corder's study, the Youth Fitness Test was used as the criterion measure. The results were analyzed by means of a chi-square applied to the data arranged in quartiles. The experimental and control groups were never directly compared. The authors concluded from the analysis that the experimental group improved significantly more than did the control group. Further, it was found by comparison with published norms that the trained group compared favorably with the nonretarded peer group.

The conclusions which can be drawn from these studies are indeed limited. Only adolsecent boys were included in three of the four investigations reported. All of the studies contained design weaknesses which raise questions concerning the results. Oliver and Corder both selected their control groups from different schools than their experimental groups. In the study reported by Solomon and Pangle, the experimenter did the training as well as the testing, so that the examiner effect alone would probably be sufficient to account for a large part of the reported gains. Despite these weaknesses the following two conclusions seem warranted:

1. Physical fitness training improves physical fitness in adolescent boys.
2. No evidence has been found which demonstrated that gains in intellectual development are the direct result of improvement in physical fitness.

Effects of Perceptual-Motor Training with Mentally Retarded Children

The contentions of Kephart (1960), Barsch (1967), Delacato (1963), Frostig (1964), and others that training in perceptual-motor abilities can improve perceptual-motor abilities, together with the research reports of the physical educability of the mentally retarded child, have inspired a number of recent investigations attempting to evaluate the effects of perceptual-motor training with the mentally retarded population. The investigations of Alley and Carr (1968), Heriot (1966), and Haring and Stables (1966), all of which were closely related to the hypotheses of the present study, were described in Chapter I. Several additional research reports deserve mention here.

Painter (1966) used a program of rhythmic and sensory-motor activities based on Barsch's Movegenic Theory (Barsch, 1963) and also on suggestions from Kephart (1960). The program emphasized exercises related to nine movement areas of Barsch's theory with children who were functioning below the median of their kindergarten class. Significant mean gains were made by the experimental group: (1) in ability to draw human figures, (2) in certain psycholinguistic abilities (especially motor encoding), and (3) on a test of sensory-motor spatial abilities designed by the author. The lack of a comparable group to control for Hawthorne and attention effects limits the interpretation of these results, but it appears that a program of perceptual-motor exercises does have some positive effects on the performance of low-achieving kindergarten children.

A study by Kershner (1967) tested the effects of a structured program of physical activities on the physical and intellectual development of public school trainable mentally retarded children. The results of this program, which was based on the Doman-Delacato Theory of Neurological Organization (Delacato, 1963), revealed statistically significant gains in favor of the experimental group on measures of mobility (creeping and crawling) and IQ (Peabody Picture Vocabulary Test). A Hawthorne group which received nonspecific activities was included in the design. The training program, although based on a different theory, was similar in intent to that suggested by Kephart. The author concluded that the techniques used may be beneficial in application with trainable mentally retarded children in a public school setting.

McLanahan (1967) used parts of the Frostig Program for the Development of Visual Perception (Frostig and Horne, 1964) as well as other training techniques including those described by Kephart. After 35 hours of training the experimental group of first grade children made greater gains than a matched control group on the Frostig test and on a reading achievement test. A second experimental group of 111 educable mentally retarded (EMR) children who participated in the same program did not show significantly higher gains than a control group of 110 EMR children. The age range among the EMR children was 8 to 12 years.

In a related study, Allen, Dickman, and Haupt (1966) provided training according to the Frostig program for a group of educable mentally retarded children in a residential school. Ten children were trained for one semester. Six other children, who served as the controls, participated in the usual school activities. Both groups were tested before and after training with the Frostig Developmental Test of Visual Perception. Using a score combining three of the five subtests, the differences between the two groups after training were found to be statistically significant.

A study was designed by Hill, McCullum, and Sceau (1967) to investigate the effects of a systematic program of exercises on the development of retarded children's awareness of right-left directionality. The 13 children in a public school class for the mentally retarded were given training in directionality by the experimenters. Training activities were selected from the Frostig program or were devised for the purpose. After training, the children significantly improved their performance on a test of awareness of directionality. No control group was included in the design.

Summary

The research reported in this section offers inconclusive evidence in regard to the effectiveness of perceptual-motor training. There are suggestions of improvement in some of the studies but none has considered the important Hawthorne effect. The contradictory evidence suggests that it is too soon for general conclusions to be drawn and that more carefully controlled research is needed to understand this potentially valuable kind of training for the mentally retarded. In the following chapters, the results of one such study are reported.

CHAPTER III

METHOD

In the previous two chapters, the background information related to the present investigation has been explored. The problems and hypotheses have been stated and relevant literature reviewed. In the present chapter, the methods employed to evaluate the hypotheses and to resolve the stated problem will be described in detail. The sample used and the population from which it was drawn are important factors in making inferences from the observed data and these factors are described in the present chapter. The three levels of the treatment condition are defined and the data gathering techniques are described. The results of the application of this method are described in the following chapter.

Subjects

The subjects for this study were selected from elementary school classes for educable mentally retarded children in the city of Harrisburg, Pennsylvania. Of the seven elementary schools which operate classes for such children in Harrisburg, six schools were able to provide adequate physical facilities to carry out the proposed experiment. All children from these six elementary schools whose most recently recorded IQ's from individually administered intelligence tests fell within the range 50 to 80; whose chronological ages, as of September 1, 1968, fell within the range 6 years-10 months to 10 years-11 months; and who were enrolled in a class for the educable mentally retarded (EMR) were included in the original student sample. There were 102 children who met all of the specified criteria and who were available for testing.

Strictly defined, the population from which this sample was drawn included only those children within the defined IQ, age, and class enrollment limits who attended public schools in the city of Harrisburg during the 1968-1969 school year. The sample and the population, then, were nearly identical except for those children enrolled in the two classes for EMR children in the one school where facilities were not provided. In a more pragmatic sense, one could assume that the population in question could more adequately be described as those EMR children within the defined limits who attend public schools in urban areas which are similar to Harrisburg, Pennsylvania.

The 102 subjects in the original sample responded, early in the school year, to the Purdue Perceptual-Motor Survey (PMS) administered by two competent examiners (See Instruments section for a description of the test). This testing was intended to identify those children who were deficient in perceptual-motor skills. Several factors were taken into consideration in determining an appropriate cut-off score to accurately identify such children. The distribution of the 102 PMS total scores appeared to be bimodal (Figure 1), with the low point between the two modes falling at approximately 66. Since each item of the PMS could be scored either 4, 3, 2, or 1, a total score of 66 would represent an average score of 3 on each item. Any total score below 66 would reflect an average of less than 3 points for each item. The mean score for the sample of 102 children was 64.81 and the median was 64. Roach and Kephart

```
84.  x
83.  xx
82.  x
81.  x
80.  x
79.  xx
78.  xxx
77.  xx
76.  xxxx
75.  x
74.  xx                  number above 65=47
73.  xx
72.  xxx
71.  xxxx
70.  xxxxxx
69.  xxx
68.  xxxxxxx
67.  xx
66.  _______________     cut-off score=65 or below
65.  xxx
64.  xx
63.  xx
62.  xxxxx
61.  xxxxxx
60.  xxxxx
59.  xxx
58.  xxxxxxx
57.  xxxxxxx
56.  xx
55.  x                    number at or below 65=55
54.  xx
53.  xx
52.
51.  xx
50.  xx
49.  x
48.
47.  x
46.
45.
44.
43.
42.
41.  x
40.
39.
38.
37.
36.
35.  x
34.
```

Figure 1. Distribution of PMS Scores. N=102, Mean=64.81, Median=64.0

(1966) recommended a cut-off score of 65 as best defining the nonachievers in their standardization sample. Considering all of these factors the cut-off score was set at 65. Even though this cut-off would include three children in the deficient group who had actually scored above the mean, it was felt that the bimodal split more accurately identified those children in need of perceptual-motor training than would a cut-off at the mean.

Using the cut-off procedure defined above, all children whose total scores on the PMS fell at or below 65 were considered to be deficient in perceptual-motor skills. There were 55 children who were included in that category as defined. These children comprised the experimental sample. One child was eliminated because of gross physical impairment. Each of the 54 remaining children was assigned a number and then each number was randomly assigned to one of three categories by use of a table of random numbers. The three resulting groups of 18 children each were then designated as Group T (Training), Group H (Hawthorne), and Group C (Control). The treatment condition for each of these groups is defined in the section on Training.

Descriptive data for each of the three experimental groups are shown in Table 1. It should also be noted here that each treatment group was represented in each of the six schools in which the investigation was conducted.

As the training progressed, some of the pupils in the experimental groups moved from the city or were transferred from the classes for EMR children. Data for one child were dropped when examiners consistently reported lack of cooperation and, subsequently, invalid test results.

TABLE 1

Data Comparing the Three Experimental Groups

Group	Number of Males	Number of Females	Number of Negroes	Number of Whites
T	13	5	10	8
H	10	8	9	9
C	13	5	10	8
Totals	36	18	29	25

The attrition rate was acceptable, however, and complete data were obtained for 16 children in each group. A comparison of the three groups of 16 children each, in terms of age, IQ, and scores on the various instruments can be found in Table 3 in Chapter IV.

Instruments

Four different data-gathering instruments were employed in this investigation. All of these tests are published instruments which are intended for general use. All except the PMS have been widely used and are well known.

Purdue Perceptual-Motor Survey (PMS)

The PMS (Roach and Kephart, 1966) was originally published as one section of Kephart's book "The Slow Learner in the Classroom" in 1960. It was published separately in standardized form with normative data in 1966 by Roach and Kephart. The survey purports to detect errors in perceptual-motor development by assessing performance in five areas of perceptual-motor functioning. Items surveying Balance and Posture, Body Image, Perceptual Motor Match, Ocular Control, and Form Perception are included. Each of the 22 items is scored either 4, 3, 2, or 1 depending upon the quality of the child's performance on the task.

The PMS was standardized on a group of 200 children in the first four grades of an Indiana school. Roach and Kephart (1966) report a test-retest stability coefficient of .95 for children in the first four grades. To establish concurrent validity, the authors secured teacher's ratings of overall academic performance for these same 200 children. These ratings were found to be correlated .65 with scores on the PMS. The standardization data also show increasing subtest scores with higher grade levels, lending support to the construct validity of the instrument.

The normative data published with the PSM manual are not compatible with the published survey. The data were collected using a 30 item survey. The number of items was reduced to 22 before publication but the data were not changed. In the present study, however, normative data will not be used. Each child will be compared to his own previous raw score on the same test.

Wechsler Intelligence Scale for Children (WISC)

The well-known WISC (Wechsler, 1949) is an individually administered test of intelligence for children from ages 5 to 15. It is divided into separate Verbal and Performance sections and yields an IQ for each section as well as a Full Scale IQ. The Verbal Scale consists of tests of Information, Comprehension, Arithmetic, Similiarities, Vocabulary, and Digit

Span. The subtests on the Performance Scale include Picture Completion, Picture Arrangement, Block Design, Object Assembly, Coding, and Mazes. The combined score is taken to be a measure of overall intellectual ability. The WISC was chosen for this study because of the separate Verbal and Performance IQ's which can be computed. The reliability and validity of the WISC and its subscales have been extensively studied and have generally been reported as quite adequate.

Wide Range Achievement Test (WRAT)

The 1965 revision of the WRAT (Jastak and Jastak, 1965) is a short test of academic achievement which may be given either individually or to groups. In the present study individual administration was used. Tests of reading, arithmetic, and spelling are included, each ranging from pre-kindergarten to college. There are two levels of this test. Level I, used in this study, is designed for use with children between the ages of 5 and 12. Level II includes all those over 12 years of age. On Level I, the spelling test begins with copying simple marks, then writing of the child's own name, and then spelling dictated words. On the arithmetic subtest, counting, reading numerals, solving simple oral problems, and written computation are included. The reading subtest entails matching letters, naming letters, and pronouncing single words. Level I of the test has been standardized on a population of 5868 and reliability coefficients are reported by the authors to range from .90 to .95 for each subtest with an average reliability of .93. The test has been widely used with the mentally retarded and the very low floor on the test makes it useful with young mentally retarded children. Validity studies reported by the authors demonstrated correlations of .81, .74, and .84 between reading, spelling, and arithmetic subtests of the WRAT respectively, and California Test of Mental Maturity IQ's. Correlation coefficients between the WRAT subtests and the Full Scale scores on the WISC, for 544 children, ranged from .60 to .77. (Jastak and Jastak, 1965)

Stanford Achievement Test (SAT)

The feature of the WRAT which makes it so valuable, its wide range, is also a limiting factor in assessing achievement gains. The magnitude of the steps between items may mask actual improvement in academic achievement. For this reason, the SAT was also selected to evaluate the hypothesis concerning achievement gain, since this test covers a much more restricted range and is therefore capable of assessing small changes in achievement level. The SAT (Kelley, Madden, Gardner, and Rudman, 1964) consists of a series of specified level achievement tests designed for use at the various grade levels of the public schools. The Primary I Battery was developed for use with children in grades 1.5 to 2.5. The six subtests included at this level are: Word Reading, Paragraph Meaning, Vocabulary, Spelling, Word Study Skills, and Arithmetic.

The SAT series was standardized on 850,000 pupils in 264 school systems drawn from all 50 states. Reliability coefficients for each of the six subtests of the Primary I Battery, based on a random sample of 1000 children, ranged from .79 to .95. Validity depends upon the curricular offerings of the school system in question.

The SAT has been widely used and generally accepted as an adequate measure of school achievement. Reviews of the test such as those found in Buros' Mental Measurements Yearbook (1965), have been generally favorable. The two forms of the test have been shown to be essentially equivalent.

Procedure

In implementing the investigation of the stated hypotheses, the procedure was logically composed of three different operations. These included pretesting, training, and posttesting. Each of these activities will be discussed under separate headings.

Pretesting

As already discussed, each of the 102 children in the original sample were tested with the Purdue Perceptual-Motor Survey. Because of the subjective nature of the scoring on the PMS, two qualified examiners rated each child on each of the tasks. The examiners were instructed to reach an agreement before assigning a final score for each item. This procedure was intended to increase the accuracy of rater judgment.

The examiners who administered the PMS, and the other pretests as well, were advanced graduate students in School Psychology or Special Education at The Pennsylvania State University or Millersville State College, who had completed coursework in individual testing procedures and who were experienced in administering individual psychological tests.

During the PMS testing, when examiners worked in pairs, the pairings were changed daily or, often, twice daily. Also, each examiner worked in a different school each day or half-day. All of these precautions were taken to randomize examiner effects, insofar as possible. The PMS testing of 102 children was completed between September 5, 1968 and October 4, 1968.

After the selection of the experimental sample as described in a previous section, the WISC was administered to each of the 54 children in the three experimental groups. This testing was also done by qualified graduate students. In some cases the examiners were the same ones who had participated in the PMS testing. If this were the case, that examiner would work in schools different from those in which he had previously tested. No examiner knew to which experimental group a child had been assigned. As with the PMS, the WISC was administered to children in six schools and the examiners changed schools frequently.

The Wide Range Achievement Test was also administered to each of the 54 children in the experimental sample. This test was given in conjunction with the WISC so that the conditions under which it was administered are the same as those described for the WISC.

In addition to the individual tests described above, a group achievement test was administered to each of the 54 children by the various classroom teachers in six schools. The Stanford Achievement Test-Primary I Battery, Form W, was employed for this purpose. Only four of the six subtests in this battery were used. The teacher administered the Word Reading, Paragraph Meaning, Word Study Skills, and Arithmetic subtests according to the standard instructions provided with the tests. It was felt that the skills measured by the other two subtests, Vocabulary and Spelling, had been adequately measured by the WISC and WRAT, respectively. The consumable booklet edition of the SAT was used to avoid the problem of transferring answers to a separate answer sheet. The pretesting phase of this project was completed by October 11, 1968, and it was then possible to begin the training activities.

Training

The independent variable in this project was carried out at three levels. Children in the training group (Group T) were seen by the trainer twice each week and received specific training in activities consistent with Kephart's conceptualization of perceptual-motor learning. The children in the Hawthorne group (Group H) were also seen by the trainer but instead of perceptual-motor training, these children played table games. The children in the control group (Group C) remained in their regular classroom schedule.

Group T. Children assigned to this treatment condition participated in an individualized, structured program of training activities designed to remediate the areas of perceptual-motor functioning in which they were found to be deficient. The activities included in the training procedure were structured to permit practice and training in the following areas of perceptual-motor abilities: (The areas described are also those which are included in the PMS.)

A. Balance and Posture. This aspect of perceptual motor abilities is measured on the survey by two kinds of activities:

1. Walking board
2. Jumping

Training activities in this area included practice and specific exercises on the walking board and balance board, jumping activities on bed springs with mattresses (used in lieu of more expensive trampolines), and hopping activities.

B. Body Image and Differentiation. There are five items on the PMS which measure the abilities included in this areas. These include:

3. Identification of Body Parts
4. Imitation of Movement
5. Obstacle Course
6. Kraus-Weber Test
7. Angels-in-the-snow

Children who achieved scores of only 1 or 2 on a majority of these items participated in such activities as trampoline stunts to improve body image, practicing angels-in-the-snow movements with variations, games and activities involving recognition and use of preferred hand or foot, learning to move or touch a named body part, and other exercises of this type.

C. Perceptual-Motor Match. Two types of items from the survey evaluate this area:

8. Chalkboard Drawing
9. Rhythmic Writing

Training activities include a wide variety of chalkboard writing, handclapping, imitation of drum beats, and other similar exercises.

D. Ocular Control. Only one area of evaluation is included in the survey:

10. Ocular Pursuits

Training in this area was primarily a series of practice exercises in following visual targets in a wide variety of settings.

E. Form Perception. Again only one type of evaluation is included:

11. Visual Achievement Forms

The training of form perception was approached through the use of such activities as pegboards, chalkboard and template drawings, and a variety of experiences with simple geometric forms.

The activities and exercises used in the training were gleaned from many sources, with the only requirements being that they fit into Kephart's general approach and that they were designed to remediate one of the areas measured by the survey. A list of sources from which activities were borrowed may be found in the Appendix.

The test items and exercises described above are not felt to be factorially pure. There is much overlap and categories are not necessarily mutually exclusive. The activities are grouped here for convenience in order of what is believed to be their primary function. Training activities are not always intended to have highly specific results. The development of motor generalizations has previously been stated to be the basis for the higher perceptual-motor processes and it is this generalized kind of pattern which the training procedures attempted to develop.

The trainer was a male advanced graduate student in School Psychology who was hired for this project and devoted full time to the project for the four and one-half month period in which training was provided. The trainer worked closely with the principal investigator and proved to be effective in motivating the children and engaging them in the activities prescribed. Each child was seen twice each week on a revolving schedule so that any given child would not miss any particular classroom lesson each time he was called out to meet with the trainer. Two children met with the trainer each time for a 30 minute session. The average number of sessions was 26 so that each child received approximately 13 hours of training during a four and one-half month period which included the Christmas holiday.

The training sessions were conducted in each of the six schools so that each child was seen in his own school. Classrooms were not used for training. Each child was called to a separate room where he met with the trainer and one other child. The equipment and supplies for training were then kept in this room. In general, adequate facilities were available, but in one school, certain training exercises could not be performed because of inadequate space and equipment.

The trainer periodically reviewed each child's progress in terms of his original difficulties on the PMS and prescribed new training activities accordingly. Also, in the event that many children demonstrated inadequate ability in some area, an exercise in that area might be included for all children in Group T for the next session. Thus there were elements of both individualized and generalized instruction included in the training program.

Group H. Children assigned to this treatment group were also seen by the trainer under the same conditions as those in Group T, except that Group H children played table games instead of doing perceptual-motor training. These children were seen by the same trainer, two at a time, for the same amount of time, in the same room, and on a similar schedule as the children in Group T. The children in these two groups were seen in pairs alternately. That is, the trainer would work with two children from Group T then two from Group H, etc. The partner with whom a child worked was also varied each time. In some cases, if the number of children was uneven, the trainer would work with one child individually rather than having three together.

The children in Group H also averaged 13 hours of participation each. Instead of training, however, these children played games such as Chutes and Ladders, Aggravation, table top pinball games and several kinds of card games including Old Maid and Fish. All of these games are played while seated at a table. The trainer attempted to equally distribute praise and encouragement among the children of both Group T and Group H. Group H was designed to control for Hawthorne and attention effects.

Group C. Children in this group maintained their regular classroom schedule except for the testing phases of the project. These children were not seen by the trainer at all. Effects of regression and other sources of unknown variance were controlled by the use of such a group.

Posttesting

Each child who was included in one of the three experimental groups and who was still available for testing, responded to the same four testing instruments as described for the pretesting phase of this project. The PMS and the WISC were administered to each of the children within a two week period beginning three weeks after the conclusion of the training program (March 17 to March 31). The examiners were again advanced graduate students in School Psychology and Special Education except for one female examiner who was a graduate student in Education who had had previous experience with the PMS. She did not participate in the WISC testing. The testing conditions were essentially the same as those for the pretesting and the same kind of rotating schedule was employed. No examiner knew which children had been included in the training program. Only rarely and by chance did an examiner test a child whom he had previously tested with the same instrument.

Near the end of the school year (May 20 to May 23) the WRAT was again administered individually to each child by several School Psychology graduate students. Conditions were the same as for the previous testing with the notable exception that for the pretesting, the WRAT was given during the same session as the WISC, whereas, for the posttesting the WRAT was administered separately. The reason for the longer time delay after training for administering the achievement tests was to allow any positive gains in cognitive functioning to affect classroom learning and, thereby, improve achievement.

During the last week in May and the first week of June 1969, the SAT was administered by the classroom teachers in the same way as before. Form X of the Primary I Battery was used for this second testing.

Data Preparation

Once all of the data had been collected, several steps were necessary in preparing those data for analysis. These procedures were carried out by the principal investigator.

The PMS was scored by the examiners. As previously mentioned, two examiners evaluated each child and reached an agreement for scoring each item. The scores for the 22 items were then totaled and this total score was used in the analysis. The WISC was examined, scored, and rechecked by the principal investigator. IQ's from all three scales of the WISC were recorded. Each examiner scored the WRAT in the standard way and then the three subtest raw scores were added to arrive at the total score which was used in most of the analyses. The scores for the three subtests were also recorded. The principal investigator hand scored the SAT protocols which had been administered by the classroom teacher. The raw scores from the four subtests used were added and this total raw score was recorded along with the separate subtest scores.

Data on sex, race, school, and treatment group were coded and punched on IBM data cards along with age in months, IQ of record, and all of the data described in the previous paragraph. These cards were then used with the IBM 360/14 computing system and other facilities of The Pennsylvania State University Computation Center, in analyzing the data. The results of this data analysis are presented in the next chapter.

CHAPTER IV

RESULTS

The data collected according to the procedures outlined in the preceding chapter were analyzed in several ways. Analysis of covariance was the technique used to test the specific hypotheses outlined in Chapter I. A second analysis using gain scores was employed to test for interaction effects among the various subgroupings. In addition, means and standard deviations were computed for each variable and correlations between the variables were determined. The results of these various analyses are reported in this chapter.

Variables

In analyzing the data, eight major variables and twenty variables of minor importance were involved. In order to clarify the results of the data analysis, definitions of each of these variables follow.

Age

The chronological age of each child in the project was computed as of September 1, 1968. This age, in months, was used throughout the data analysis. Of course, the ages changed during the course of the study, but since the change was constant, it was not taken into account.

IQ of Record

The most recently recorded IQ on the child's school records was used in the initial selection of children for the study and this IQ was retained as part of the data. These IQ's were the results of individual psychological evaluations performed by certified school psychologists as part of the ongoing program of the Harrisburg City Schools. The recency of the tests on which the IQ of record was based ranged from four months to three years. Of the original sample of 102 children, 86 had Stanford-Binet Intelligence Scale IQ's as the most recently recorded IQ. Wechsler Intelligence Scale for Children IQ's were recorded for 13 children and 3 had recorded IQ's from other tests.

PMS

As already noted in Chapter III, the subtest scores on the Purdue Perceptual-Motor Survey were combined to yield a total score. This total score is used in the data analysis. PMS total score defines two variables, since the test was used both before and after training.

WISC IQ

Altogether, six variables are defined by results of the Wechsler Intelligence Test for Children. The test yields three IQ's: Verbal Scale IQ (VIQ), Performance Scale IQ (PIQ), and Full Scale IQ (FSIQ). An IQ on each of the three scales was determined for each child both before and after training.

WRAT

A total score combining the three subtests of the Wide Range Achievement Test was used in testing the hypothesis of improved achievement. Again pretest and posttest scores were used. Reading, Spelling and Arithmetic subtests were also used as variables. Pretest and posttest results were included.

SAT

Four subtests of the Stanford Achievement Test, Primary I Battery were administered to each child. Form W was used before training and Form X was used after the training period. The combined score of the four subtests was used as the major variable in testing the hypothesis of improved achievement. The scores for the Word Reading, Paragraph Meaning, Word Study Skills, and Arithmetic subtests were also used in a separate analysis.

Correlation Analysis

Correlations among the major variables before training are presented in Table 2. Product moment correlations coefficients were computed for every pair of variables using data from each subject where scores from both variables were available. The number of subjects involved in each coefficient is printed in Table 2. The reader should note the correlations of age with many of the major variables, since reference will be made to this correlation later in this chapter. Also of importance to the constructs involved in this study are the correlations between PMS scores and each of the achievement measures, both of which represent statistically significant differences from zero. These correlations, of course, were based on a rather narrow range of achievement scores, suggesting that the indicated relationships are probably meaningful. It is also noteworthy that the PMS scores were shown to be related to IQ of record even though the IQ range was relatively small. This finding supported the previous work of Ismail and Gruber (1967).

TABLE 2

Product-Moment Correlation Coefficients of Major Variables

Variable	Age	IQ Rec	PMS	VIQ	PIQ	FSIQ	WRAT	
IQ of Record	-.02							N=102
PMS	.40*	.26*						N=102
VIQ	-.05	.50*	.15					N= 54
PIQ	-.04	.51*	.28*	.59*				N= 54
FSIQ	-.06	.56*	.25	.85*	.92*			N= 54
WRAT	.56*	.18	.33*	.32*	.16	.25		N= 54
SAT	.56*	.24	.42*	.40*	.39*	.44*	.82*	N= 52

*Statistically significant difference from zero, where $p<.05$, two tailed test.

Hypothesis Testing

The hypotheses as stated in Chapter I can also be stated in null form in order to simplify the statistical terminology and procedures involved in hypotheses testing. Although the original hypotheses predicted improvement in scores as the result of training, these hypotheses can be tested with reference to posttest differences among the groups. The logic of this, of courses, is that, first of all, all groups achieved higher scores on the posttests than on the pretests (see Table 3), so that improvement is assumed. Secondly, we are analyzing between-group differences to see if these assumed gains are the result of the

TABLE 3

Summary Data for Three Treatment Groups Before and After Training

Variable		Before Training			After Training		
		Group T	Group H	Group C	Group T	Group H	Group C
Age	mean	114.31	110.87	120.25			
	s.d.	14.6	13.0	9.7			
I.Q.	Mean	68.00	67.31	68.88			
	s.d.	6.2	5.9	5.6			
PMS	mean	58.50	56.56	59.38	70.06	68.06	70.69
	s.d.	4.3	5.7	4.3	5.6	8.2	6.5
WISC-FSIQ	mean	69.19	68.19	71.12	74.25	71.62	73.31
	s.d.	8.0	11.2	8.1	6.8	6.7	5.1
WISC-VIQ	mean	72.94	69.43	71.25	75.50	70.12	72.81
	s.d.	6.0	9.1	7.5	6.8	6.7	5.1
WISC-PIQ	mean	70.69	72.56	76.31	77.69	78.56	79.06
	s.d.	10.6	14.0	8.8	9.0	15.8	8.7
WRAT-TOTAL	mean	72.31	67.75	79.12	80.38	77.12	88.12
	s.d.	16.2	18.6	16.4	15.7	20.4	15.4
SAT-TOTAL	mean	72.69	75.25	82.44	85.75	86.00	101.56
	s.d.	29.0	34.7	28.4	31.1	36.1	27.2

Note: *N* = 16 for each group.

experimental treatment or if they are simply the result of other experimentally nonmanipulated factors. Since the three experimental groups were equivalent except for the independent variable of level of training in perceptual-motor skills, the nonmanipulated factors are assumed to be the same for all groups. Any differences among the groups, therefore, could be attributed to the independent variable (training). In reference to the above discussion, then the hypotheses will be stated in this chapter in terms of posttest differences between the experimental groups. The null hypotheses are as follows:

1. There are no differences among the scores of the Training, Hawthorne, or Control Groups on the Purdue Perceptual-Motor Survey administered after the training was completed.
2. There are no differences among the Full Scale IQ's of the Training, Hawthorne, or Control Groups on the Wechsler Intelligence Scale for Children administered after the training was completed.
    a. There are no differences among the groups on Verbal IQ.
    b. There are no differences among the groups on Performance IQ.
3. There are no differences among the scores of the Training, Hawthorne, and Control Groups on the achievement tests administered after the training was completed.
    a. There were no differences among the groups on the Wide Range Achievement Test.
    b. There were no differences among the groups on the Stanford-Achievement Test.

Summary data for the three treatment groups before and after training are presented in Table 3. Means and standard deviations for each of the pretest-posttest variables as well as for age and IQ of record are included in this table.

The reader will note that differences exist among the means of the three groups on some of the variables before training. Analysis of variance applied to these data, however, indicates that none of these differences is statistically significant at the .05 probability level.

Inspection of Table 3 indicates that means for all groups were higher on the posttest than on the pretest for each variable included in the table. In Table 4 are reported the t ratios comparing the pretest means with the posttest means on each of the six variables for each of the three treatment groups. It is interesting to note that a statistically significant ($p<.01$) improvement was manifest on the PMS and both achievement tests for children in all three groups. With regard to WISC scores, which are by definition age-corrected, the control group did not show statistically significant improvement. Among the two groups who were seen by the trainer, t tests comparing pretest and posttest IQs on the Performance Scale and Full Scale were statistically significant at $P<.05$ for Groupt T but not for Group H.

These statistics, although not direct comparisons among the three groups, do suggest that the Hawthorne effect may have been operating where IQ was the variable under consideration.

TABLE 4

Results of t Tests for Correlated Samples Comparing

Pretest with Posttest on Six Variables

Group	PMS	VIQ	PIQ	PSIQ	WRAT	SAT
Group T	8.64**	2.22*	3.27**	3.35**	4.77**	4.69**
Group H	5.88**	0.50	3.27**	2.96**	6.23**	3.30**
Group C	8.75**	0.96	1.14	1.12	7.63**	4.41**

Note: N = 16 for each group, df = 15 for each t test,

*<.05, two tailed test

**<.01, two tailed test

Analysis of Covariance

As can be seen from inspection of Table 3, there were differences among the three groups before training began, even though random selection procedures had been followed.

Lindquist (1953) suggests that there is a method of statistically controlling such uncontrolled variations by making appropriate adjustments in the criterion means for the various treatment groups and also in the error term used in the test of significance. These adjustments are computed by means of a regression equation based on the correlation coefficents between the variables and the coefficient of regression of the criterion variable on the uncontrolled variable. This regression equation results in expected deviations for each subject from the criterion mean based on the actual deviation from the mean of the concomitant variable. These expected deviations are then subtracted from each subject's actual criterion score and then the usual methods of analysis of variance are applied to these adjusted scores. The procedure described here is known as the analysis of covariance, and this was the procedure employed in testing the hypotheses in the present investigation. A complete description of the method can be found in Lindquist (1963, pp. 317-319). It is possible to use this procedure to statistically control more than one concomitant variable at one time. In some cases two concomitant variables were involved in the study under consideration here.

Since age was found to be correlated with all variables other than IQ's (see Table 2), age was used as one covariate in analyzing scores on the PMS, WRAT, and SAT. Because pretest results were available for all variables, they were always included as a covariate. Stated another way, the perceptual-motor and achievement variables were analyzed using two covariates (age and prescore), while the intelligence variables were handled using one covariate (prescore). The results of the analysis of covariance are presented in Table 5. None of the _F_ ratios was statistically significant at the .05 probability level. Therefore, all of the null hypotheses as stated were retained. That is, there were no statistically significant differences among the scores of the three groups on any of the six major variables. It should be noted here that the _F_ ratio was large enough to approach statistical significance on two variables--PMS total scores and WISC Verbal IQ. In both cases the highest mean of the three groups was attained by Group T.

TABLE 5

Analysis of Covariance of Major Variables, Summary Tables[a]

Variable	Covariates	Adjusted Means	Source	Mean Square	df	F ratio
PMS-2	Age and Prescore	Group T=73.87				2.52 n.s.
		Group H=68.84	Treatments	108.13	2	
		Group C=70.10	Error	42.94	43	
VIQ	Prescore	Group T=74.52				2.13 n.s.
		Group H=71.13	Treatments	44.25	2	
		Group C=72.79	Error	20.80	44	
PIQ	Prescore	Group T=79.52				0.50 n.s.
		Group H=79.02	Treatments	33.12	2	
		Group C=76.76	Error	66.50	44	
FSIQ	Prescore	Group T=74.47				0.74 n.s.
		Group H=72.55	Treatments	24.30	2	
		Group C=72.17	Error	32.98	44	
WRAT Total	Age and Prescore	Group T=81.07				0.22 n.s.
		Group H=82.13	Treatments	7.92	2	
		Group C=82.42	Error	35.57	43	
SAT Total	Age and Prescore	Group T=89.54				1.46 n.s.
		Group H=87.60	Treatments	294.27	2	
		Group C=96.18	Error	201.42	43	

[a] *N*=16 for each group, 48 for each variable.

Note: $F_{2,44}$ (.05)$\geq$3.23.

n.s.=not significant at $p<.05$.

From inspection of the data and from the reports of the trainer, it appeared that the younger children in Group T seemed to benefit more from the training than did the older children. Originally, it had been planned that only children younger than ten were to be included in the study. Practical considerations, however, made it necessary to include some older children in the sample. An analysis of covariance was therefore done comparing only those children under ten years of age (as of September 1, 1968) in each of the three groups. The results of this technique are arranged in Table 6. Only those F ratios comparing the groups on the PMS and on Verbal IQ exceeded 1.0. The F ratios for the other variables are, therefore, not reported in the table.

TABLE 6

Covariance Summary Tables for Children Younger Than 10 Years of Age[a]

Variable	Covariates	Adjusted Means	Source	Mean Sq.	df	F
PMS	Prescore	Group T=76.31 Group H=66.89 Group C=65.03	Treatment Error	235.98 49.97	2 21	4.72*
VIQ	Prescore	Group T=74.37 Group H=69.35 Group C=73.60	Treatment Error	59.47 23.12	2 21	2.57

[a] N for Group T=6, N for Group H=10, N for Group C=7.
Note: F(.05) 2, 21=3.52
*statistically significant at p<.05.

Table 6 shows that the adjusted means of the three groups differ on posttest scores for the PMS. Since the F statistic does not locate the differences which are statistically significant, a t test for multiple comparisons as described by Kirk (1968, p. 74) was applied. In comparing the mean PMS score of Group T with that of Group C the resulting t statistic is 2.38. The value from the table of the t distribution with 21 degrees of freedom at the .05 probability level is 2.08. The t value resulting from the comparison of Group T with Group H is 2.05. It can be concluded from this analysis that, for children under 10 years of age, training in perceptual-motor skills results in higher scores on the PMS than does no training at all. The data suggest, however, that training does not result in higher scores than does special attention without specific training.

Although there were no statistically significant differences among the three groups on total scores on the WRAT and the SAT, it was still possible that a difference might have existed on one of the seven subtests included in the two test batteries. Therefore an analysis of covariance was performed on the posttest scores on each of these subtests using age and pretest scores as covariates. The results of these analyses are displayed in Table 7. Again no statistically significant differences were found among the three groups on any of the subtests analyzed. It appears worth noting, however, that on the SAT, the highest adjusted mean scores on all subtests were achieved by Group C.

TABLE 7

Analysis of Covariance of Achievement Subtest Scores, Summary Table[a]

Variable	Covariates	Adjusted Means	Source	Mean Square	df	F ratio	
WRAT Reading	Age and Prescore	Group T=34.00 Group H=34.14 Group C=34.61	Treatment Error	1.565 8.343	2 43	0.19	n.s.
WRAT Spelling	Age and Prescore	Group T=24.85 Group H=25.11 Group C=24.72	Treatment Error	0.530 7.452	2 43	0.07	n.s.
WRAT Arithmetic	Age and Prescore	Group T=21.93 Group H=22.69 Group C=23.19	Treatment Error	6.220 4.480	2 43	1.39	n.s.
SAT Word Meaning	Age and Prescore	Group T=15.85 Group H-15.55 Group C=19.10	Treatment Error	56.418 20.748	2 43	2.07	n.s.
SAT Para. Meaning	Age and Prescore	Group T=14.50 Group H=14.73 Group C=15.58	Treatment Error	4.893 40.087	2 43	0.12	n.s.
SAT Word Study	Age and Prescore	Group T=28.14 Group H=27.71 Group C=29.02	Treatment Error	6.532 25.492	2 43	0.26	n.s.
SAT Arithmetic	Age and Prescore	Group T=30.76 Group H=30.00 Group C=32.36	Treatment Error	20.048 60.826	2 43	0.33	n.s.

[a] $\underline{N}=16$ for each group.

Note: $\underline{F}_{2,43}(.05) \geq 3.23$.

n.s.=not significant at $p<.05$.

Gain Score Analysis

Of the hypotheses generated in the earlier sections of this paper, none were entirely supported by the results of this investigation and subsequent data analysis. There were a few trends, however, which suggested that further review of the data might be in order. Table 8 shows the results of one such analysis. In Table 8 are recorded the means and standard deviations of gain scores for each variable. That is, each subject's pretest score was subtracted from his posttest score on each variable. Means and standard deviations were then computed using these "gain" scores. The results are reported for each of the treatment groups and for all three groups combined.

TABLE 8

Means and Standard Deviations of Gain Scores

Variable	Group T		Group H		Group C		Total	
	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
PMS	15.56	7.2	11.50	7.8	11.31	5.2	12.79	7.0
VIQ	2.56	4.6	.69	5.5	1.56	6.5	1.60	5.5
PIQ	7.00	8.6	6.00	7.4	2.75	9.7	5.25	8.6
FSIQ	4.94	6.0	3.44	4.6	2.31	7.9	3.56	6.3
WRAT	8.06	6.8	9.38	6.0	8.88	4.7	8.77	5.8
SAT	13.06	11.1	10.75	13.0	19.13	17.3	14.31	14.2
	N = 16		N = 16		N = 16		N = 48	

As previously noted, Table 8 indicates that positive gains were made by all groups on each of the measures used, although there were frequent negative gain scores by individual subjects in all three groups. These negative individual scores are reflected in the relatively large standard deviations.

The gain scores calculated in the manner already described were also subjected to the analysis of variance technique. A single classification analysis of variance was performed comparing the three treatment groups on each of the six posttest variables. The results of these analyses are reported in Table 9. None of the F ratios generated by these analyses was significant at the .05 level of probability, indicating that the various treatment conditions, including training, had no effect on gain scores on any of the test instruments used.

Calculation of analysis of variance using three or more factors was not possible because of the small numbers of subjects in each cell. It was possible, however, to evaluate some interaction effects by using several analyses with two classifications. In developing these analyses, several catagorizations of data were determined. Chronological age was divided into two levels. Those children who were 9 years-11 months (119 months) or younger, as of September 1, 1969, were considered the "younger" group and those who were 10 years old (120 months) or older as of the same date, were considered the "older" group. The children were also classified according to the IQ of record. Those whose recorded IQ was 60 or below were included in the "lower" IQ group and those whose IQ was 70 or above were called the "higher" IQ group.

In order to be able to evaluate interaction effects among the classification variables and treatment effects, a series of 5 two-factor

TABLE 9

Combined Summary Tables for Analyses of Variance of Major Variables Using Gain Scores

Variable	Group Means	Scource	Mean Squares	df	F Ratio
PMS	Group T=15.56 Group H=11.50 Group C=11.31	Treatment Error	92.27 46.61	2 45	1.98 n.s.
VIQ	Group T=2.56 Group H=0.69 Group C=1.56	Treatment Error	14.08 31.23	2 45	0.45 n.s.
PIQ	Group T=7.00 Group H=6.00 Group C=2.75	Treatment Error	79.00 74.11	2 45	1.07 n.s.
FSIQ	Group T=4.94 Group H=3.44 Group C=2.31	Treatment Error	27.75 40.04	2 45	0.69 n.s.
WRAT Total	Group T=8.06 Group H=9.38 Group C=8.88	Treatment Error	7.02 34.63	2 45	0.20 n.s.
SAT Total	Group T=13.06 Group H=10.75 Group C=19.12	Treatment Error	299.31 192.22	2 45	1.51 n.s.

Note: *N*=16 for each group.
n.s. = not significant at $p<.05$, tabled value of F(.05) 2.45=3.21

analyses of variance procedures were used, combining each of the variables of age, IQ of record, sex and race with the treatment variable on each of the 6 gain score variables. From all of these analyses there were no F ratios which were significant at the .05 probability level.

There was a trend, in those analyses in which race was a factor, which suggested that Negroes in all three treatment groups achieved greater gain on the PMS than did whites. The F ratio in this case was 2.96 with 1 and 42 degrees of freedom. The F value from the table at the .05 probability level is 4.08. Although the F is not statistically significant, this trend is reported because the same result was found in three separate analyses of variance of PMS scores comparing race with the other classification variables. In one case the F was statistically significant where $p<.05$.

Summary

In summarizing the results reported in this chapter the absence of significant overall findings seems of first importance. For the total sample of children in the three treatment groups, all of the three major null hypotheses had to be retained. Of the three hypotheses, only Hypothesis I received any support at all and then only partial support for those children under age 10. Hypothesis II and III were not supported.

Regarding PMS gain scores, there was some minimum evidence suggesting that Negroes in all three treatment groups achieved greater gains than did whites. Correlations showing relationships between age and PMS scores and between PMS scores and achievement scores were reported. In the following chapter these results will be analyzed and discussed.

CHAPTER V

DISCUSSION AND ANALYSIS OF RESULTS

The results presented in Chapter IV did not clearly resolve the problem posed for this investigation. None of the hypotheses was strongly supported in its original form. There were some results, however, which deserve attention. In this chapter, each of the hypotheses will be analyzed in turn and the importance of the experimental results as related to each hypotheses will be discussed. Other findings of importance will also be reviewed in the present chapter.

Hypothesis 1

The first hypothesis concerning improvement in perceptual-motor performance was partially supported for children under 10 years of age. Only the $\underline{t}$ test comparing the difference between the training and control groups was statistically significant, although the $\underline{t}$ comparing the difference between the training and Hawthorne groups was extremely close to significance. It should also be noted that the $\underline{F}$ ratio from the analysis of covariance comparing the three treatment groups on PMS scores approached statistical significance. There seems to be enough evidence to tentatively conclude that training in perceptual-motor skills may be effective in improving perceptual-motor performance in younger educable mentally retarded children but does not seem to be effective for older educable children. Even such a conclusion cannot be positively stated since all of the evidence does not conclusively substantiate this finding.

One possible explanation for the differential effects of training among age groups may be related to the fact that pretest PMS total score was correlated with age (r=.50), suggesting that pretest PMS scores were lower for the younger group.[1] In effect, this allows more room for improvement for the younger group. This effect is not merely a statistical one, however. It seems likely that the younger children, by virtue of fewer years of experience, had achieved less than the older group in the perceptual-motor area, and therefore had more to learn than the older children. In a developmental sequence such as that described by Kephart, it may also be the case that the learning involved at a lower level may be less difficult than that required at higher levels, thus allowing the younger child to gain more quickly from training.

The partial support obtained for the effectiveness of training with younger children conflicts with the findings of Alley and Carr (1968). Their subjects (ages 7-5 to 9-10) would have been classified as younger children in the present study but Alley and Carr found no differences after training between the experimental and control groups on a score combining selected subtests of the PMS. The training procedure used by these investigators was similar to that of the present study except that the training was done daily over a two month period whereas in the present study, training was conducted twice weekly for four and one-half months.

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[1] Mean PMS prescore for Group E (10 or over) = 60.20.
Mean PMS prescore for Group E (under 10 only) = 55.67.

It may be that the PMS is not a very sensitive instrument in detecting changes in perceptual-motor abilities. In the Alley and Carr study, for example, the children were trained to a criterion of three successful trials on each of the training tasks outlined by Kephart but the PMS showed no posttest differences between the performance of the trained group and that of a control group. This result appears curious in that the PMS is based on the same activities as those used in the training. On the other hand, it was possible to demonstrate differences on the PMS as a result of training with the younger mentally retarded children in the present investigation.

Roach and Kephart (1966) pointed out in their discussion of the PMS that the instrument was really a survey designed to detect errors in perceptual-motor development rather than a quantitative test, but the authors used a total score in analyzing their normative data. Although the use of such a total score may not be totally justified on statistical grounds, it appears to be a useful method for comparison of groups of individuals.

In comparing the results of the present study with those of Alley and Carr, it must be recalled that, in the latter study, the children were not selected on the basis of a deficiency in perceptual-motor abilities as were the subjects in the present study where only those below a cut-off score on the PMS were included. It could be expected, therefore, that greater improvement would accrue for the children in the present study since some of the children in the Alley and Carr study may have already been proficient in the abilities being trained.

In reference to the sensitivity of the PMS, the study by Haring and Stables (1966) is informative. These authors used the PMS to identify areas of difficulty and conducted their training accordingly. As a post-test measure, however, they devised their own test which was more specific and comprehensive in the two areas measured than is the PMS. On their more specific test differences were found in favor of the experimental group.

Although previous studies by Oliver (1958), Corder (1968), and Solomon and Pangle (1967) have demonstrated rather conclusively that training in physical education with educable mentally retarded boys can significantly improve physical fitness, attempts to improve general perceptual-motor functioning by training does not appear to be as successful. The studies mentioned above involved physical fitness including such training techniques as push-ups, broad jumps, and running. The results were measured by instruments such as the AAHPER Youth Fitness Test (1961). The present study and those of Alley and Carr and Heriot involved many elements of a more cognitive nature such as form perception, chalkboard writing, and identifying body parts. Obviously, learning in the cognitive area is difficult for the mentally retarded. This additional factor of cognitive learning may partially account for the different results achieved by the two types of training programs. One implication of this discussion is that the mentally retarded may require a much longer time to improve on a primarily cognitive learning task than on a primarily physical one. The assumption that motor learning is easier was supported by the work of Howe (1959) who demonstrated that mentally retarded children, although beginning at a lower level, were able to maintain a rate of learning in motor skills similar to that of a group of children with average intellectual ability. This line of reasoning suggests that one reason for the failure of the present study to show improvement by the experimental group on the PMS as a result of training may be related to the relatively small amount of training they received. Since cognitive learning was involved in the upper levels of the Kephart training technique, more time may have been needed to allow these mentally retarded children to practice and learn the activities involved. Haring and Stables seven-month training program appears to have been more effective than the relatively shorter programs used by Alley and Carr and the present study. Heriot's year long program also appeared to be effective.

Hypothesis II

The second hypothesis which predicted gains in intellectual functioning as a result of training was not supported by the data. The analysis of covariance did reveal a trend in the direction of supporting the hypothesis for Verbal IQ but this trend was not substantiated by any other analysis.

At the present time, it appears that there is no evidence that training educable mentally retarded children in perceptual-motor skills has any effect upon intellectual functioning. Although Oliver and Corder reported increases in IQ following their physical education programs, neither of these investigators were able to demonstrate that the increases were a direct result of the training. Alley and Carr reported that their training group did not show statistically significant improvement in concept formation performance as measured by the

Illinois Test of Psycholinguistic Abilities. Although the research has not been supportive of intellectual gains as a result of perceptual-motor training programs, such gains have not been shown to be impossible. Several studies have indicated trends in a positive direction in favor of the experimental group. The question should, therefore, remain open for further research.

In a research project involving a somewhat different population, Kershner (1967) trained a group of trainable mentally retarded children in perceptual-motor development according to the rationale espoused by Doman and Delacato (Delacato, 1963). This technique employs training activities of a primarily motor nature such as creeping, crawling, using dominant limbs, and practice in visual pursuit activities, as well as sensory stimulation. Kershner found that the experimental group improved in IQ as measured by the Peabody Picture Vocabulary Test to a degree which represented a statistically significant difference over a control group who participated in a nonspecific program of motor activities. This study further confounds the available research findings and serves to emphasize the need for more research in this area.

Since no evidence was found in the present study for increases in intellectual functioning as a result of training on any of the three WISC scales, Hypotheses IIa and IIb remain unsupported. The prediciton that improvement in Performance IQ would be found while improvement in Verbal IQ would not was unsubstantiated. On the other hand, Corder's (1966) finding of Verbal IQ gain for his training group over a control group was not replicated. In the present study it was anticipated that Performance IQ would improve most since the training program was designed with a perceptual orientation whereas Corder's training activities were physical in nature but socialization as well as verbal praise and encouragement were emphasized. The generalizations which can be made from the results of both of these studies are inconclusive since the populations from which the samples were selected differed as to the training procedures involved.

Hypothesis III

No evidence was found to support the prediction that training would improve academic achievement. Neither the Wide Range Achievement Test (Hypothesis IIIa) nor the Stanford Achievement Test (Hypothesis IIIb) indicated differences among the treatment groups. Of course, the training was not directly related to classroom work but, according to Kephart's rationale, improvement in perceptual-motor functioning should improve cognitive functioning which, in turn, should lead to improved classroom achievement. The results of Hypothesis I and II would suggest that Hypothesis III would not be supported either since improvement in neither perceptual-motor ability nor intellectual functioning were found as a result of training. Even when the hypotheses were tested for those children who had shown greater improvement in perceptual-motor ability than a control group (children under 10 years old), support was not found for improved intelligence nor improved achievement. Without substantiated improvement in the ability to function in the classroom (intelligence), achievement gain would not be expected.

This line of reasoning was not borne out by the research of McLanahan (1967), however. He demonstrated statistically significant gains in reading achievement but not in IQ by using the Frostig training program with normal first grade children. The Frostig program, however, is more closely allied to regular classroom work than is that prescribed by Kephart.

Swanson (1969) found improvement in reading achievement as a result of a training program very similar to the one used in the present study. Swanson's subjects were regular second grade Negro children from educationally deprived backgrounds, so that her results are probably not generalizable to the mentally retarded population.

From the available research, the only valid conclusion seems to be that improvement of academic achievement for mentally retarded children as a result of perceptual-motor training has not been demonstrated.

Overall Improvement of Scores

No hypotheses were generated in relation to the overall improvement of psychometric test scores from pretest to posttest for the three treatment groups. The fact that many of these gains were statistically significant, however, suggests that important variables are operating. The influence of the well-known statistical regression effect is probably one factor involved. The regression effect predicts that extreme scores on a pretest tend to regress toward the mean on a posttest. Since the subjects in the present study scored below the population means on all of the variables studied, we would expect their scores to be higher (closer to the mean) on the posttest as a result of the regression effect.

Another important factor in the overall gains found for the three groups is test familiarity. Not only had each child responded to the same test previously, but he had also become used to the procedures and the routine involved in individual testing.

Maturation also plays a part in test-retest improvement, especially on tests involving measures of physical development such as the PMS. Roach and Kephart (1966) reported that PMS scores increased with age, presumably as a result of maturation. It as also found, in the present study, that PMS total score was significantly correlated with age. The time delay between pretest and posttest on the PMS in the present study varied between five and six and one-half months so that it seems possible that maturational changes could have occurred during that time.

It would be anticipated, of course, that classroom learning would also account for some of the increases in test scores over time. This factor would be especially important in regard to the achievement measures. One other factor which deserves mention would be the effects of the motivation aroused by the special attention given to those children involved in the sample. Even those children in Group C were called from their classrooms at least five times for individual testing. The Hawthorne effect seems to be operating in this regard but, in this case, it was not evaluated.

The relative contribution of each of these factors to pretest-posttest improvement is unknown. The experiment was not designed to evaluate these effects so that it can only be noted here that improvement did occur.

Other Findings

Several important considerations were suggested by the results of statistical analyses not directly bearing on the hypothesis. The statistically significant, although moderate, correlations between the PMS and the WRAT and SAT respectively support the relationship described by Roach and Kephart (1966). These investigators demonstrated a relationship between PMS scores and teacher's ratings of academic performance. The relationship between perceptual-motor abilities and achievement was also demonstrated by Lowder (1956) who used only the Visual Achievement Forms from the PMS and found a statistically significant correlation between performance on this task and teachers' ratings of pupil achievement. The evidence from each of these studies leads to the conclusion that perceptual-motor performance appears to be moderatly related to academic achievement.

The indication that Negro children seemed to improve in perceptual-motor abilities as a result of training whereas white children did not is of interest, especially in reference to future research. The data were not conclusive in this respect, but the tendency was of sufficient magnitude to be reported as a variable worth considering in future investigations. No previous studies of perceptual-motor training have analyzed the variable of race and, in fact, the present study was not designed to evaluate its effects with precision.

General Considerations

The stated hypotheses were generally unsupported by the results of this investigation, although there were suggestions that training such as described in this study could be at least marginally effective. One reason for the lack of statistical significance in the results may have been due to the high level of variability within groups. The children, having been selected from public school classes for the educable mentally retarded, were certainly not a homogenous sample. In such classes are found children with brain damage, children with various kinds of learning disabilities, and children who are emotionally disturbed, as well as those who are mentally retarded. No attempt was made in the present study to screen the children in terms of these factors. Only those with obvious physical defects were eliminated. Therefore, the sample contained a heterogeneous assortment of children. This heterogeneity may have partially accounted for the high variability within groups. With such highly variable groups, differences between the groups must be relatively large before statistical significance is achieved. Perhaps the selection of a more homogenous sample would increase the precision in an investigation of this type. Even when the data for a few children with extreme scores were left out, however, the analysis of covariance did not show significant differences among the three treatment groups. (See Appendix for summary table of this analysis.)

Another factor which may have contributed to the relatively high variability within groups was examiner effect. As reported in Chapter III, the examiners in the project were randomly assigned to subjects for testing so that any one child may have responed to as many as five different examiners. The examiner effect was therefore randomly distributed among the three groups. This source of variability would, however, probably lead to an increase in the error of measurement and would again require that large differences be found between the treatment groups if they were to be statistically significant. Here again, more precision may be attainable through experimental control of such sources of variability.

Summary

In this chapter each of the hypotheses has been discussed in relation to the previous research so that generalized conclusions could be formulated. The importance of the finding of overall gains was discussed along with other significant results. Some general considerations with respect to the efficiency of the present study were also mentioned. In the following chapter, all of the information presented in the previous five chapters will be summarized and general conclusions, implications, limitations and suggestions for future research will be listed.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The investigation described in this paper was designed to experimentally test the effectiveness of a structured program of perceptual-motor training activities with educable mentally retarded children. Kephart's Perceptual-Motor Hypothesis (Kephart, 1960) maintains that a child's motor patterns provide the basis for meaningful orientation to space and time, and that later, more complex behavior develops from a foundation of motor movement patterns. Kephart suggests that breakdowns in the developmental process of perceptual-motor learning can interfere with the establishment of a stable perceptual-motor world, causing subsequent difficulties in the classroom. Kephart feels that a planned sequence of exercises designed to develop motor generalizations and orientation in space and time can be effective in remediating learning problems for many children who have experienced such breakdowns. This logic can also be applied for mentally retarded children who, because of faulty learning processes, have failed to adequately develop motor generalizations.

It is generally accepted in the literature that mentally retarded children are inferior to normal children in motor performance. (Francis and Rarick, 1963; Howe, 1959; Malpass, 1960; Sloan, 1951) Although these descriptive studies have presented a rather bleak picture of the motor capabilities of the mentally retarded, experimental studies have shown that motor proficiency can be improved in the retardate through training.

(Corder, 1966; Oliver, 1958; Solomon and Pangle, 1967) Furthermore, Solomon and Pangle report that as a result of their training, "the level of physical fitness in educable mentally retarded children can be so significantly improved as to allow a favorable comparison with the nonretarded peer group" (Solomon and Pangle, 1967, p. 177).

Other studies have shown that structured physical education programs with the mentally retarded may affect cognitive functioning as well as physical proficiency. (Corder, 1966; Oliver, 1958) Several correlational studies have indicated a relationship between motor ability and intelligence. (Ismail and Gruber, 1967; Malpass, 1960) If we postulate some interference with a particular stage of perceptual-motor development as a possible etiological factor of poor motor performance in the mentally retarded, and if this poor motor performance can be remediated, we would expect a concomitant improvement in perceptual processes as well. Specifically, the following question is posed: *What are the effects of a structured program of physical activities, consistent with Kephart's conceptualization of the Perceptual-Motor Hypothesis, on the perceptual-motor development, intellectual development, and school achievement of public school educable mentally retarded children who have shown evidence of poor perceptual-motor abilities*?

Method

The original pool of subjects for this study were 102 educable mentally retarded children enrolled in special classes in the Harrisburg, Pennsylvania, public schools. Only children between the ages of 6 years-10 months and 10 years-11 months, whose most recently recorded IQ fell within the range 50 to 80 were included. On the basis of the results of the Purdue Perceptual-Motor Survey (PMS), 54 children in six schools were found to be deficient in perceptual-motor ability. These children were randomly assigned to one of three groups of 18 children each. Children in one of the groups, designated as Group T (Training), participated in an individualized, structured program of training activities. designed to remediate the areas of perceptual-motor functioning in which each child was found to be deficient. The training was conducted twice weekly for four and one-half months by a specially hired trainer who traveled from school to school. Two children worked together with the trainer for 30 minutes each session. The children in this group received an average of 13 hours of training.

Children assigned to Group H (Hawthorne) also met with the trainer under the same conditions as those for Group T except that Group H children played table games (cards, Chutes and Ladders, etc.) instead of doing perceptual-motor training. The trainer attempted to distribute praise and encouragement equally among the children in both groups.

Children in Group C (Control) maintained their regular classroom schedule except for the testing phases of the project. The trainer saw the children in Groups T and H on a variable schedule so that no child systematically missed the same regular class periods each week.

All of the children in the three experimental groups responded to the PMS, Wechsler Intelligence Scale for Children (WISC), Wide Range Achievement Test (WRAT), and Stanford Achievement Test (SAT) before the training began. Following training, the PMS and WISC were administered again. Two months later, the two achievement tests were administered to the same group.

Results

Hypothesis I which predicted improvement of perceptual-motor abilities as a result of training was not supported. Analysis of covariance of PMS scores, using age and PMS prescore as control variables, revealed no significant differences among the three groups. A separate analysis computed for those children under 10 years of age, however, found a significant difference in favor of Group T over Group C on PMS total scores. The difference between Group T and Group H was very close to statistical significance at the .05 probability level.

Hypothesis II which predicted improvement in intellectual performance was not supported. The $\underline{F}$ ratio from the analysis of covariance of WISC Full Scale IQ's was not statistically significant at the .05 level. When the analysis of covariance was applied to the Verbal and Performance IQ's separately, the differences among the three groups were not statistically significant either.

For Hypothesis III which predicted improved achievement as a result of perceptual-motor training, no support was found. The covariance applied to both WRAT and SAT scores, using age and prescore as control variables, yielded $\underline{F}$ ratios which were not statistically significant.

Although the hypotheses were generally not supported, there were some findings of interest. All three groups of children demonstrated statistically significant improvement from pretest to posttest on PMS total scores and both achievement tests (WRAT and SAT). These overall gains are probably the result of the combined effects of regression, test familiarity, maturation and learning, and the effect of special attention given those children being tested. In addition, both Group T and Group H showed statistically significant improvement in WISC Full Scale IQ, suggesting the importance of the Hawthorne effect on intelligence test performance.

Statistically significant correlation coefficients were found between PMS scores and age (R = .40, N = 102), supporting the construct validity of the PMS, and between PMS scores and IQ of record (r = .26, N = 102), supporting the work of Ismail and Gruber (1967). PMS scores were also found to be related to achievement test scores (r = .33 for WRAT, N = 54; r = .42 for SAT, N = 52).

Gain scores were also computed and subjected to analysis of variance with two factors for each analysis. The results of these analyses were similar to those using covariance. None of the classification variables of age, IQ, race, or sex was found to interact with the treatment variable, level of training.

Discussion

One possible explanation for the differential effects of training among age groups was related to the fact that pretest PMS score was significantly correlated with age, in effect, allowing more room for improvement for the younger children. It may also be the case that activities at the lower levels are more easily learned than those at the higher levels.

It appears that the PMS may not be a very sensitive instrument for detecting changes in perceptual-motor abilities. Studies using other posttest measures have been able to demonstrate improvement, while such improvement has not been demonstrated for mentally retarded children on the PMS.

One reason for the difference between the findings of the physical fitness training programs and the perceptual-motor training programs may be that the latter require some cognitive learning, which, of course, is difficult for the mentally retarded. Motor learning, on the other hand, may not be so difficult. (Howe, 1959)

In regard to the effects of training on intelligence, the Hawthorne effect has been demonstrated to be an important variable. None of the studies reported were able to show gains in intellectual functioning as a direct result of training with educable mentally retarded children. Improvement in academic achievement was not found in the present study. Such improvement has been found with more specific training programs such as that of Frostig (1964).

One factor which limited the statistical interpretation of scores in the present study was the high level of variability of scores within each of the groups. This variability was possibly due to the heterogeneous sample of children included and the potentially high error of measurement because of the effects of the variety of examiners.

Conclusions

The following conclusions are based upon the results of the present study in the light of previous research. Many of these conclusions are tentative and stand in need of support through replications of the research.

1. A short term structured program of training in perceptual-motor activities, following Kephart's suggestions, has no effect on the perceptual-motor performance of elementary school educable mentally retarded children.
2. There is some evidence to suggest that such training might be marginally effective in improving the perceptual-motor performance of educable mentally retarded children who are younger than 10 years of age.
3. There is no evidence that training in perceptual-motor abilities has any effect on the intellectual functioning of educable mentally retarded children.
4. There is no evidence that gross motor training in perceptual-motor abilities has any effect on the academic achievement of educable mentally retarded children.
5. There is a moderate relationship between perceptual-motor ability and intellectual ability among educable mentally retarded children.
6. There is a moderate relationship between perceptual-motor ability and academic achievement among educable mentally retarded children as well as among mentally normal children.

Implications

The results of the present study suggest several implications for educators. In view of the lack of positive findings, those persons charged with developing programs for educable mentally retarded children will have a rationale for avoiding short term itinerant programs of perceptual-motor development.

In regard to Kephart's Perceptual-Motor Hypothesis, the present study raises questions as to the validity of that hypothesis, but the study cannot be construed as disproving the hypothesis.

With somewhat less certainty, the study implies that training in perceptual-motor abilities may be effective for younger educable children, perhaps even for those of preschool age as Heriot (1966) suggests.

The study has several implications for the design of future research projects on this topic, but these will be listed under the section on Suggestions for Further Research.

Limitations

The study presented here is limited in its interpretation by several factors. The important limitations are listed below.

Sample

Generalizations can be made regarding this study to the extent that the sample is representative of the population. The results can be generalized only to groups similar to that of the present study. Strictly speaking, the sample in the study was not randomly selected. In effect, the entire population of children in one city who met the selection criteria were included. Generalization to groups of children in other urban centers can be made only to the extent that those children do not differ from those in Harrisburg, Pennsylvania.

Specifically, it should be noted that the children in Harrisburg were enrolled in public school special education classes housed in regular elementary school buidlings. Generalization to institutional populations is probably not warranted, especially in view of the fact that researchers have demonstrated differences in motor abilities between institutional and noninstitutional retardates. (Malpass, 1960) Generalizations to children in other types of educational programs should be made with caution.

Measurement

The results of any experiment are also limited by the adequacy of the measurement techniques involved. It has already been mentioned that the total score on the PMS may not be a valid indication of total perceptual-motor performance. The level of measurement of the PMS is probably ordinal.

The validity of standardized achievement tests is limited to the extent that the content of the test corresponds to the content of the educational curriculum being followed. Tests standardized on normal school population are not necessarily valid for students enrolled in special classes. This would be especially true of the more specifically curriculum-oriented SAT.

Design

Although the design employed appeared adequate for testing the stated hypothesis, much more information could have been gathered through the use of a factorial design evaluating various levels of the major demographic variables. Such a design could not be used in the present study because of the limited number of subjects.

Suggestions for Further Research

The outcome of the study reported here has suggested several important considerations for future research. Some of these considerations are factors which researchers should be aware of in conducting research projects in this field, while others are suggestions for new studies which could help to resolve the remaining problems in regard to perceptual-motor training with mentally retarded children. It is, of course, assumed that the suggested studies would be conducted with the suggested research factors kept in mind.

Research Factors

1. The Hawthorne effect and/or other attention variables appear to be powerful factors in studies involving training programs. Any study evaluating such programs should account for these variables.
2. To adequately evaluate the effects of perceptual-motor training, more sensitive measures of perceptual-motor abilities than the PMS are probably necessary.
3. The amount of time spent in training should be considerably longer than that which would be considered adequate for normal children. The time factor, however, is probably related to the amount of cognitive learning which is involved in the training procedure.

4. Following the lead of Ismail and Gruber (1967) it is probably necessary to identify those training techniques which require more cognitive activity than others. If possible, it would be desirable to specify the relative level of cognitive learning involved in each training task.
5. Within-group variability could be more adequately controlled through screening and selection of more homogenous samples. Furthermore, the error of measurement could be reduced by allowing each examiner to test the same child both before and after training with any given test.

Research Studies

1. A more comprehensive investigation of the problem posed in the present study would be desirable. Such a study should include a larger number of subjects in a factorial design balanced on such factors as sex, IQ levels, age levels, race, and socio-economic status.
2. It is recommended that a study of perceptual-motor training with the mentally retarded be carried out using achievement measures specifically designed for mentally retarded children in special classes.
3. A study comparing the effects of physical fitness training with the effects of perceptual-motor training for similar samples under similar conditions would be valuable in attempting to understand the variables involved in such training programs.

4. A follow-up study on the children in the present project would be informative as to the long range effects of such training. It may be that a latency period for consolidation is necessary before such effects are manifest.
5. At least one replication of this study, with improved controls, should be conducted before the benefits of such training programs are ruled out.

REFERENCES

Allen, R. M., Dickman, I., and Haupt, T. D. A pilot study of the immediate effectiveness of the Frostig-Horne Training Program with educable retardates. Exceptional Children, 1966, 33, 41-42.

Alley, G. R. The effects of systematic sensory-motor training on sensory-motor, visual perception and concept formation performance of mentally retarded children. (Doctoral dissertation, University of Iowa) Ann Arbor, Michigan: University Microfilms, 1967, Number 68-895.

Alley, G. R. and Carr, D. L. Effects of systematic sensory-motor training on sensory-motor, visual perception and concept formation performance of mentally retarded children. Perceptual and Motor Skills, 1968, 27, 451-456.

American Association for Health, Physical Education and Recreation. Youth Fitness Test Manual (Second edition). Washington, D.C.: Author, 1961.

Barsch, R. H. Achieving perceptual-motor efficiency. Seattle: Special Child Publications, 1967.

Brace, D. K. Motor learning of feeble-minded girls. Research Quarterly, American Association for Health, Physical Education and Recreation, 1948, 19, 269-275.

Buros, O. K. (Ed.) The sixth mental measurements yearbook. Highland Park, New Jersey: Gryphon Press, 1965.

Corder, W. O. Effects of physical education on the intellectual, physical, and social development of educable mentally retarded boys. Exceptional Children, 1966, 32, 357-364.

Delacato, C. H. The diagnosis and treatment of speech and reading problems. Springfield, Illinois: Charles C. Thomas, 1963.

Di Stephano, M. J., Ellis, N. and Sloan, W. Motor proficiency in mental defectives. Perceptual and Motor Skills, 1958, 8, 231-234.

Francis, R. J. and Rarich, G. L. Motor characteristics of the mentally retarded. Cooperative Research Monograph No. 1. Washington: U. S. Department of Health, Education and Welfare, 1960.

Frostig, M. and Horne, D. The Frostig program for the development of visual perception. Chicago: Follett, 1964.

Gibson, J. J. and Gibson, E. J. Perceptual learning: differentiation or enrichment? *Psychological Review*, 1955, *62*, (Whole No. 1).

Halgren, M. R. Opus in see sharp. *Education*, 1961, *81*, 369-371.

Haring, N. G. and Stables, J. M. The effect of gross motor development on visual perception and eye-hand coordination. *Physical Therapy*, 1966, *46*, 129-135.

Heath, S. R. Rail-walking performance as realted to mental age and etiological type among the mentally reatrded. *American Journal of Psychology*, 1942, *55*, 240-247.

Heriot, J. T. A perceptual-motor program for preschool retardates: Results and implications for research design. In *Perceptual-Motor dysfunction, evaluation and training*. Proceedings of Occupational Therapy Seminar. Conducted by School of Occupational Therapy, University of Wisconsin, Madison, Wisconsin, 1966, pp. 25-54.

Hilgard, E. *Conditioning and Learning*. New York: Appleton-Century, 1961.

Hill, S. D., McCullum, A. H., and Sceau, A. G. Relation of training in motor activity to development of right-left directionality in mentally retarded children. *Perceptual and Motor Skills*, 1967, *24*, 363-366.

Howe, C. E. A comparison of motor skills of mentally retarded and normal children. *Exceptional Children*, 1959, *25* (8), 352-354.

Ismail, A. H. and Gruber, J. J. *Motor aptitude and intellectual performance*. Columbus, Ohio: Charles E. Merrill, 1967.

Jastak, J. F. and Jastak, S. R. *The Wide Range Achievement Test: Manual of Instructions, 1965 edition*. Wilmington, Delaware: Guidance Associates, 1965.

Kephart, N. C. *The slow learner in the classroom*. Columbus, Ohio: Charles E. Merrill, 1960.

Kephart, N. C. Perceptual-motor aspects of learning disabilities. *Exceptional Children*, 1964, *31* (4), 201-206.

Kephart, N. C. The needs of teachers for specialized information on perception. In W. M. Cruickshank (Ed.), *The teacher of brain injured children*. Syracuse, New York. Syracuse University Press, 1966, pp. 171-180.

Kelly, T. L., Madden, R., Gardner, E. F. and Rudman, H. C. *Stanford Achievement Test*. New York: Harcourt-Brace, 1964.

Keogh, B. J. and Keogh, J. F. Pattern copying and pattern walking performance of normal and educationally subnormal boys. American Journal of Mental Deficiency, 1967, 71, 1009-1013.

Kershner, J. R. Doman-Delacato's theory of neurological organization applied with retarded children. Harrisburg: Bureau of Research, Department of Public Instruction, Commonwealth of Pennsylvania, 1967.

Kershner, J. R. and Bauer, D. H. Neuropsychological and perceptual-motor theories of treatment for children with educational inadequacies. Harrisburg: Bureau of Research, Department of Public Instruction, Commonwealth of Pennsylvania, 1966.

Kirk, R. E. Experimental design: Procedures for the behavioral sciences. Belmont, Californaia: Wadsworth, 1968.

Kirk, S. A. Research in education. In H. A. Stevens and R. Heber (Eds.), Mental retardation. Chicago: University of Chicago Press, 1964.

Lindquist, E. F. Design and analysis of experiments in psychology and education. Boston: Houghton Mifflin, 1953.

Lord, F. M. Elementary models for measuring change. In C. W. Harris (Ed.), Problems in measuring change. Madison, Wisconsin: University of Wisconsin Press, 1963, pp. 21-38.

Lowder, R. G. Perceptual ability and school achievement. Unpublished doctoral dissertation, Purdue University, 1956.

Malpass, L. F. Motor proficiency in institutionalized and noninstitutionalized retarded children and normal children. American Journal of Mental Deficiency, 1960, 64, 1012-1015.

Malpass, L. F. Motor skills in mental deficiency. In M. R. Ellis (Ed.), Handbook of mental deficiency. New York: McGraw-Hill, 1963, pp. 602-631.

McClanahan, L. J. The effectiveness of perceptual training for slow learners. (Doctoral dissertation, Stanford University) Ann Arbor, Michigan: University Microfilms, 1967, Number 67-16,543.

Oliver, J. N. The effect of physical conditioning exercises and activities on the mental characteristics of educationally subnormal boys. British Journal of Educational Psychology, 1958, 28, 155-165.

Painter, G. The effect of a rhythmic and sensory motor activity program on perceptual motor spatial abilities of kindergarten children. Exceptional Children, 1966, 33, 113-116.

Rabin, H. M. The relationship of age, intelligence, and sex to motor proficiency in mental defectives. Amercian Journal of Mental Deficiency, 1957, 62, 507-516.

Roach, E. G. and Kephart, N. C. The Purdue Perceptual-Motor Survey. Columbus, Ohio: Charles E. Merrill, 1966.

Sloan, W. Motor proficiency and intelligence. American Journal of Mental Deficiency, 1951, 55, 394-406.

Solomon, A. and Pangle, R. Demonstrating physical fitness improvement in the EMR. Exceptional Children, 1967, 34, 177-181.

Stein, J. U. Motor function and physical fitness of the mentally retarded. Rehabilitation Literature, 1963, 24, 230-242.

Strauss, A. A. and Kephart, N. C. Psychopathology and education of the brain-injured child. New York: Grune and Stratton, 1955.

Swanson, R. G. A study of the relationship between perceptual-motor skills and the learning of word recognition. (Doctoral dissertation, University of South Carolina) Ann Arbor, Michigan: University Microfilms, 1968, Number 69-480.

Wechsler, D. The Wechsler Intelligence Scale for Children. New York: The Psychological Corporation, 1949.

APPENDIX A

Summary Tables from the Analysis of Covariance with Selected Subjects

TABLE 10

Summary Table: Analysis of Covariance with Selected Subjects, PMS Scores

Covariates	Adjusted Means	N	Source	Mean Square	df	F
Age and	Group T=74.46	13	Treatments	104.62	2	2.26
Prescore	Group H=69.07	14	Error	46.38	36	
	Group C-70.28	14				

Note: *F* was not significant at $p<.05$.

TABLE 11

Summary Table: Analysis of Covariance with Selected Subjects, Verbal IQ

Covariates	Adjusted Means	N	Source	Mean Square	df	F
Prescore	Group T=74.22	13	Treatments	16.91	2	1.02
	Group H=72.32	14	Error	16.56	37	
	Group C=72.18	14				

Note: *F* was not significant at $p<.05$.

APPENDIX B

Sources Containing Perceptual-Motor Training Activities

Sources from which Traning Activities Were Selected for the Present Study

Benyon, S. D. *Intensive programming for slow learners*, Columbus, Ohio: Charles E. Merrill, 1968.

Ebersole, M., Kephart, N. C., and Ebersole, J. T. *Steps to achievement for the slow learner*, Charles E. Merrill, 1968.

Kephart, N. C. *The slow learner in the classroom*. Columbus, Ohio: Charles E. Merrill, 1960.

Kephart, N. C. Perceptual-motor aspects of learning disabilities. *Exceptional Children*, 1964, *31* (4), 201-206.

Kephart, N. C. The needs of teachers for specialized information on perception. In W. M. Cruickshank (Ed.), *The teacher of brain injured children*. Syracuse, New York: Syracuse University Press, 1966, pp. 171-180.

Kephart, N. C. Teaching the child with a perceptual-motor handicap. In M. Bortner (Ed.), *Diagnosis and education of the brain-injured child*. Springfield, Illinois: Charles C. Thomas, 1967.

Kephart, N. C. and Chaney, C. N. *Motoric aids to perceptual learning*. Columbus, Ohio: Charles E. Merrill, 1968.

Radler, D. H. and Kephart, N. C. *Success through play*. New York: Harper and Row, 1960.

Roach, E. G. and Kephart, N. C. *The Purdue Perceptual-Motor Survey*. Columbus, Ohio: Charles E. Merrill, 1966.

Sutphin, F. I. *A perceptual testing and training handbook for first grade teachers*. Winter Haven, Florida: Winter Haven Lions Club, 1964.

Vallet, R. E. *The remediation of learning disabilities: A handbook of psychoeducational resource programs*. Palo Alto, Calif.: Fearon, 1967.

Van Witsen, B. *Perceptual training activities handbook*. New York: Teachers College Press, 1967.

Other Selected Sources Listing Useful Training Activities

Barsch, R. H. Achieving perceptual-motor efficiency. Seattle: Special Child Publications, 1967.

Conner, F. P. and Talbot, M. E. An experimental curriculum for young mentally retarded children. New York: Teachers College Press, 1964.

Frostig, M. and Horne, D. The Frostig program for the development of visual perception. Chicago: Follett, 1964.

Jolles, Isaac. A teaching sequence for training of visual and motor perception. American Journal of Mental Deficiency, 1958, 63, 252-255.

VITA

Kirk L. Fisher was born on July 6, 1942, in Altoona, Pennsylvania. He graduated from the Altoona High School in 1960. His higher education began in January, 1961, with enrollment at the Altoona Campus of The Pennsylvania State University. Graduation from Penn State with a B.S. degree in Psychology was accomplished in 1964.

After teaching mentally retarded children in the Altoona public school system for one and one-half years, Mr. Fisher entered the graduate school at Penn State in 1966 and earned the M.S. degree in School Psychology in 1969. While attending graduate school, he was employed by the University as a graduate assistant working as a school psychologist at the Penn State Demonstration School at the Cresson State School and Hospital for Mentally Retarded Children.

Mr. Fisher holds the Certificate in School Psychology for Pennsylvania and was employed during the 1968-1969 school year as an intern psychologist with the Harrisburg City Schools, Harrisburg, Pennsylvania. During the 1969-1970 academic year, he will be employed as a school psychologist with the Lancaster City School District, Lancaster, Pennsylvania.

Mr. Fisher is a member of Phi Delta Kappa, and holds student affiliation with the American Psychological Association and the Council for Exceptional Children.